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THE GEOLOGY OF CYPRUS.

BY

C. V. BELLAMY, M.I.C.E., F.G.S.,

Late Director of Public Works in Cyprus,

AND

A. J. JUKES-BROWNE, B.A., F.G.S.,

Late of the Geological Survey of Great Britain.

PUBLISHED BY AUTHORITY.

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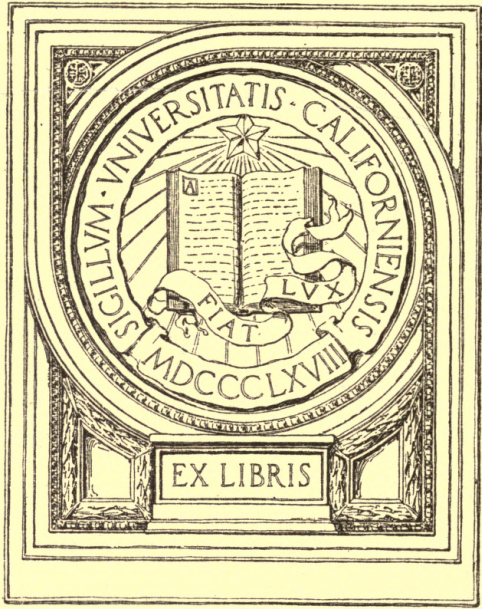
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EXCHANGE



A GEOLOGICAL MAP OF CYPRUS

North Latitude

35°

34°

33°



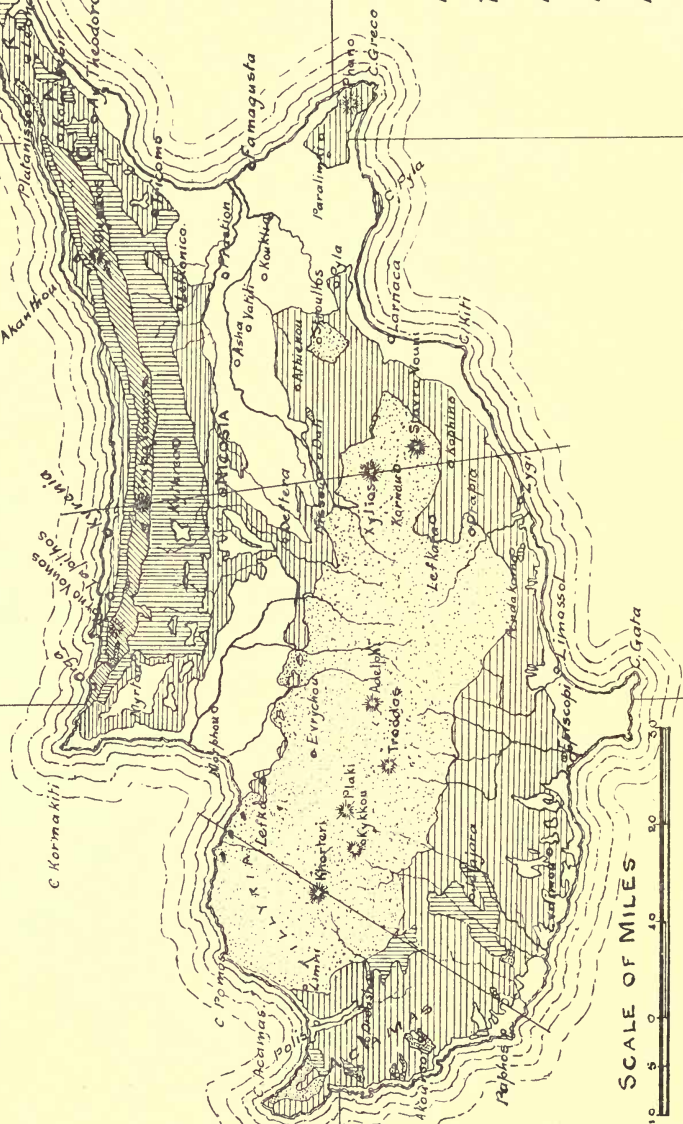
IGNEOUS

TRYPANIAN

KYTHREAN

IDALIAN

PLIOCENE & C.



SCALE OF MILES



34°

33°

East of Greenwich

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NOTE.—In the following pages the pronoun *we* has been used because the whole of the original manuscript has been revised, altered, and added to by both of us, so that we are jointly responsible for most of the opinions expressed therein. At the same time, as Mr. Jukes-Browne has not visited Cyprus, for all statements referring to observations made on the spot Mr. Bellamy is responsible, except where other authorities are mentioned. On the other hand, all the descriptions of the lithological composition and microscopical structure of rocks, as well as comments on the fossils and inferences as to the relative age of the several rock-groups, are by Mr. Jukes-Browne.

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THE GEOLOGY OF CYPRUS.

CHAPTER I.

PHYSICAL FEATURES AND GEOLOGICAL FORMATIONS.

THE island of Cyprus is situated in the extreme eastern basin of the Mediterranean Sea, about equally distant from the coast of Asia Minor or Caramania on the north and Syria on the east; the distance in each case being about 60 miles.

The island measures about 140 miles in length from south-west to north-east and about 60 miles from north to south, and contains about 3584 square miles. The coast-line is very irregular, and is indented with several extensive bays, chief of which are the Krysokhou, Morphou, Famagusta, Larnaca, Akrotiri, and Episkopi. On the south coast an irregularly rectangular promontory juts out to the south-west of Limassol, known as Akrotiri, on which is situated the Limassol Salt Lake, and divides the Episkopi from the Akrotiri bays; this peninsula culminates to the south-east in Cape Gata.

At the western extremity the district of Paphos tapers off in a north-westerly direction to form the promontory of the Acamas, terminating in Cape Acamas; and on the eastern seaboard south of Famagusta is another promontory which culminates in the conspicuous headland of Cape Greco.

To the north-east the land trends away to form the remarkable horn-like peninsula called the Carpas, which is about 45 miles long and never more than 7 or 8 miles wide, terminating in Cape Andreas, off which are situated the Klides Islands.

The island may be described as divided into two portions, a southern and a northern, by the great central plains which are known as the Messoria or Mesaorian plains. These extend from the shores of Famagusta Bay on the east to those of Morphou Bay on the west, and are nearly 60 miles long and about 12 to 15 wide.

They constitute an undulating tract of country, whose greatest

altitude is reached in the neighbourhood of Nicosia, which is just under 500 feet above sea-level.

These central plains are bounded on the north by the Kyrenia Mountains, which rise steeply from both flanks to altitudes of 2500 and 3000 feet, though the width of area above 1500 feet is seldom more than 4 or 5 miles. On the south and south-west is a much larger area of mountainous country, including the Machera, the Adelphi, the Troödos and the Tillyria Mountains. Of these the highest is Mount Troödos or "Chionistra," sometimes also, but erroneously, called Mount Olympus, 6406 feet above the sea. Mount Adelphi rises to over 5000 feet, and there are numerous other peaks exceeding an altitude of 4000 feet.

The low country is generally given over to the cultivation of cereals, the upper levels to the growth of the vine, and the summits are more or less clad in forest trees.

Previous Publications.

The earliest methodical description of the geology of Cyprus is that by A. Gaudry. His explorations were made in the years 1853 and 1854, and were published by the Geological Society of France in 1859.* His memoir is an elaborate one, dealing not only with the succession of stratified rocks so far as he could distinguish them, but also with the igneous rocks and with the mineral substances found in the island. It was accompanied by a geological map on a scale of $\frac{1}{250,000}$ (or 3.9 stat. miles to an inch), but it is entitled *Essai d'une carte géologique*, and is therefore only a sketch map, based on a rough and not very accurate survey of the island by de Mas Latrie.

The island was also visited about this time by the German geologist Unger, who, in collaboration with M. Kotschy, published an account of its geology in 1865,† differing on some points from the conclusions of M. Gaudry.

In 1880 Mr. R. Russell was sent out to report on the means of obtaining a better water-supply in Cyprus; the results of his examination were published in a Foreign Office paper, and in the report of the British Association for 1881.

Still later the island was visited by Prof. A. Bergeat (now of Clausthal), who chiefly studied the massive igneous rocks. His researches were published in 1892 in a paper which contains an excellent account of the igneous rocks, together with some interesting observations on the sedimentary series.‡ These will be referred to more

* *Mem. Soc. Geol. de France*, series 2, tom. vii., pp. 149-314.

† *Die Insel Cypern*. F. Unger and T. Kotschy. 8vo. Vienna (1865).

‡ *Tscherm. Min. and Petr. Mitth.*, vol. xii. p. 263. Vienna.

particularly in the sequel, and we are indebted to Dr. J. W. Evans for calling our attention to this memoir.

An excellent map of the island having been prepared in 1882 by Captain H. H. Kitchener, this formed a suitable basis for a more complete and accurate geological map, the materials for which were obtained during a residence of five years in Cyprus. The resulting geological map on a scale of $5\frac{1}{2}$ miles to an inch has recently been issued.*

Rock specimens taken from the different formations were brought home and examined in this country, others have since been sent over by Mr. Nicolls, the present Director of Public Works, so that the following pages embody the results of observations in the field and the consideration of specimens and notes at home.

Geological Formations in Cyprus.

The oldest formation found in Cyprus appears to be partly of Cretaceous and partly of Eocene age, but as no fossils have yet been obtained from its older limestones and marbles this is not certain, and consequently possible error will be avoided by giving it a local name. For this we have chosen *Trypanian* from Mount Trypa or "Trypa Vounos," a summit on the Kyrenian range on the northern side of the island.

Between the Trypanian limestones and the Tertiary sandstone series there seems to be a gap and unconformity, and again we are unable to fix the precise age of the deposits which form the basal part of this series. They were compared by Gaudry to the "Macignos" of Italy, and referred to the Eocene period, but as they seem to pass up into the Miocene deposits they are more likely to be mainly of Oligocene age. We propose to call them *Kythræan* from the town of Kythræa, where they are well developed and exposed.

The succeeding deposits are fossiliferous, and have been identified as belonging to the Miocene series, but as they have some special features, it will still be convenient to continue the use of local nomenclature and to call them *Idalian*, from the ancient town of Idalia (now Dali). In this we are really following Mr. Russell, who called them the "Idalia Beds."

Above the Miocene there is another break and unconformity, and during this interval great masses of volcanic rocks were thrust up through the pre-existing strata. A subsequent subsidence in Pliocene time allowed of further deposition, and the succession closes with some accumulations of Pleistocene date.

* A Geological Map of Cyprus, compiled by C. V. Bellamy, and printed in colours, with an explanatory key of 16 pages. E. Stanford, London, 1905. Price 6s.

The succession, characters, and approximate thicknesses of these formations are shown in descending order by the following table:—

NAME AND AGE.		CHARACTERS.	THICKNESS.
	Pleistocene . .	{ Alluvial deposits, sandy limestones, } sands and conglomerates . . }	up to 50
	Pliocene . .	{ Shelly limestones, with calcareous } sands and sandstones . . }	100 to 150
	Break . .	Intrusion of igneous rocks . .	
Idalian.	{ Newer (Miocene). .	{ White shelly limestones, white } chalky limestones, and marly } chalks with layers of flint . }	about 1000
	{ Older (Oligocene?) .	{ Grey and yellowish marls, with beds } of gypsum . . . }	400
	Kythraean (Upper Eocene or Oligocene) . .	{ Grey felspathic sandstones and } sandy shales . . . }	? 1500
Trypanian.	{ Eocene? . .	Greenish shales with hornstone bands	? 100
	{ Cretaceous? .	{ Grey limestones and dolomites, } white and pink marbles, both } massive and laminated . . }	possibly 5000

CHAPTER II.

THE TRYPANIAN SERIES. (CRETACEOUS—EOCENE?).

The Compact Limestones.

THE range of the Kyrenia Mountains, which forms the northern rampart to the Central Plains, commences on the west a little to the north-west of the village of Kormakiti and about $5\frac{1}{2}$ miles eastward of the cape of that name.

The place where the Trypanian rocks rise to the surface is known under the name of "Skasmata" (? the precipices), a term suggestive of the peculiar physical features of the neighbourhood. ^{AREA OF BREAKING (WAVES?)}

From this point the range extends for a length of 28 miles in a direction east by south to the neighbourhood of Kythrea, and thence onwards for another 30 miles in a direction east by north to near Komi-kebir, at the commencement of the Carpas, that is to say, for a distance of 58 miles in all.

The tract of country occupied by the Trypanian limestones is nowhere more than $2\frac{1}{2}$ miles in width, although the summits of the range reach altitudes ranging from 2000 to 3000 feet throughout the greater part of its length, as the following heights will show.

Commencing at the western end, the most prominent points are: Kornos Vounos, a conspicuous feature of the landscape and the point at which the main range of hills commences, 3106 feet; Trypa Vouno, 3085 feet; Buffavento, 3135 feet; Kakotissa, 3014 feet; Pentadactylos, 2405 feet; Yaila, 3065 feet; Olymbos (the true Cyprian Mount Olympus), 2431 feet; and Sina Oros, 2380 feet.

Beyond the last-named summit the hills slowly diminish in altitude until the neighbourhood of Komi-kebir is reached, to the north of which the ridge is about 1000 feet above the sea.

When it is remembered that at no point are any of these summits as much as 4 miles from the coast along a horizontal line, an idea will be obtained of the precipitous character of the hills, and how abruptly the rocks which compose the hill-range rise from those which form the slope between it and the sea. The highest point, indeed, (Buffavento,) is little more than 3 miles distant from the coast-line.

This range of hills has just as imposing an appearance when viewed from the south, and the following is a translation of the description given by Gaudry: "The traveller who enters the plain of Nicosia and sees in the distance the abrupt precipices of these rocks rising behind the 'macigno' hills would suppose that he was looking at immense walls built on the top of slopes. Their scarps contrast with the rounded forms of the igneous masses of the Olympian chain [Tröodos range] on the other side of the plain. Their outlines stand out with splendid boldness against the almost perpetual azure of the Cyprian sky. On three of the most lofty summits there still exist the ruins of strongholds which from their position were impregnable; these castles seem as it were suspended in mid-air; they are the castle of Buffavento, the castle of St. Hilarion, and that of Kantara."

This singular range of hills is mainly composed of limestones, which have been so tilted by crust movements that the beds are now in a nearly vertical position, and it has been impossible to ascertain which are the oldest and which the newest. For this formation it is proposed to adopt the name Trypanian, from Mount Trypa, one of the highest central summits. The rocks have been much altered by compression and by igneous intrusions, and no fossils have ever been found in them, so that their exact age is unknown, but Gaudry referred them to the Cretaceous period.

Gaudry had travelled in Greece, and was familiar with the aspect of the Grecian Cretaceous limestones and marbles. He says of the Trypanian rocks: "Generally they are compact, and have the appearance of the Hippurite limestones in Attica; sometimes they are ceroidal and semi-crystalline, and then they are exactly like the limestones of Mount Lycabettus, near Athens. It is noticeable too, as in Greece, that as they become more crystalline in texture the lighter is the tint they assume."

These hard, compact limestones are generally grey, bluish, or brownish, but there is also a black variety which, according to Gaudry, owes its colour to the presence of bitumen, and he states that if the black limestone is heated it becomes white. A dark indigo-blue limestone is frequently met with, and it would seem that the darker the hue the more bituminous and friable is the rock. Some of these dark limestones are also dolomitic.

Associated with the grey and blue limestones are others of various hues—yellow, red, pink and white, or yellow veined with white. Many of these are completely crystalline, and are capable of yielding decorative marbles of delicate and beautiful tints. There are also brecciated marbles.

Here and there along the range the limestones are pierced by masses

of igneous rock, syenite, quartz-felsite, liparite, and dolerite, and in the vicinity of these masses the stratified rocks are completely marmorised, sometimes passing into saccharine marbles, which are either white or tinted with various shades of red, from pink to claret colour. In other places the beds in contact with the igneous rock are schistose limestones; but it is not certain that these belong to the Trypanian series, nor is it clear that their schistosity is due to contact metamorphism.

A number of specimens of the Trypanian limestones were collected and have been submitted to examination, the results of which will be found in Appendix I.

The only locality in Cyprus, outside the range of the Kyrenia Mountains, where similar crystalline limestones have been found is west of Akourso, in the extreme south-west of the island. They occur here on a ridge, which is flanked partly by Kythraean sandstones, and partly by igneous rocks, but the outcrop is only about a mile and a half in length.

With regard to the thickness of the Trypanian limestones as exposed it can only be guessed, because no succession of beds can be made out. Gaudry put it at 2000 metres (about 6500 feet), but this is thought to be too high an estimate. To begin with, the position of the Kythraean sandstones on each side of the range shows its general structure to be that of an anticline, so that parts are probably duplicated, and there is certainly also some duplication by faulting. The average width of the range is about 2 miles, so that if duplication were complete the real thickness might be 5200 feet.

The Lapithos Beds (? Eocene).

Throughout the western half of the Kyrenian range, and within the area coloured red for the Trypanian Series on the geological map, there is a set of hard shaly marls, or fissile limestones, which seem to be more intimately associated with the Trypanian limestones than with the Kythraean beds, but are possibly independent of both. As, however, it was not possible to indicate the narrow outcrop of these beds on the map, and as no proof of their unconformity was detected, they were included in the Trypanian Series.

Gaudry describes them as schistose marls and limestones, and classed them as Cretaceous. He says that at first he attributed their special features to metamorphism by contact with the igneous rocks, but he afterwards changed this opinion, and believed them to be a separate subdivision of the series which we have called Trypanian. They are also mentioned by Russell under the description of "white fissile limestones," but he does not dissociate them from the compact (Trypanian) limestones.

An examination of the area where these beds are best developed, *i.e.* around Orga, Kornos Vounos, Lapithos, and Sisklipos, shows that they are much dislocated by faults and folds, so that in some places the shaly limestones seem to alternate with the compact limestones, and in others to be closely associated with the Kythraean sandstones and conglomerates, for at this western end of the range the conglomerates of the latter series diminish in thickness and are sometimes altogether cut out by faults.

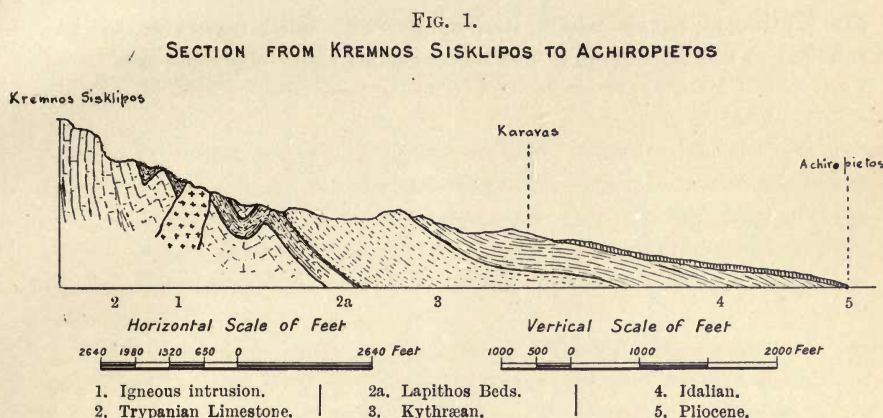
Lithologically the Lapithos Beds may be described as thin-bedded marly limestones, but they are often much disturbed and broken up, thus acquiring the aspect of calcareous shales, while near igneous masses they are often converted into a striped schistose or even a massive crystalline rock. Their normal colour is a pale greenish or greyish white, but sometimes they are nearly white, and in some places they become pink, salmon, or magenta coloured, doubtless from an infusion of iron. Layers of opaque flint or chert occur, and vary from 2 to 6 inches in thickness. These flint-bands are quite different from those in the Idalian limestones, but are similar to the water-worn fragments which are found in the Kythraean conglomerates, a fact which seems to establish the later date of the latter.

These fissile and shaly limestones form nearly continuous but very narrow bands, both on the northern and southern sides of the central Trypanian ridge, as far east as Mount Pentadactylos, but in the more eastern portion of the range they are only occasionally seen.

Dr. Bergeat's paper has only recently become known to us, but there seems to be no doubt that it was in one of the flinty bands of the Lapithos Beds, as we propose to call them, that he detected foraminifera belonging to the *Nummulitidae*. The following is a translation of his statement (*op. cit.*, p. 8): "At the western end of the mountains near Lapithos there are well-exposed layers of silicified limestone, which contain small forms of Nummulites in large numbers, and dip discordantly toward the limestone hills. In association with these beds I found light green shaly marls without fossils, which probably underlie the former, and may possess a similar extension along the whole northern chain. . . . The Nummulite beds I have only seen near Lapithos; the greenish marls I have observed everywhere in the range west of Pentadactylos, and they exhibit their strongest development on the western declivity of the mountains where they almost take the place of the Miocene sandstones, which are everywhere else well developed."

Dr. Bergeat gives a section through Lapithos, but it is not very intelligible, nor does it appear to be drawn to scale. A sketch-section was made by one of us on the spot, and from this Fig. 1 has been copied to show how the facts then observed were interpreted at the

time. As Lapithos and Karavas are virtually one village, the line of section must be nearly the same as that of Dr. Bergeat's, but possibly a little more to the eastward. The fissile limestones border the compact limestone of the Kremnos, and are traversed by a dyke of igneous rock; on the slope below Kythraean sandstones are seen, and the village stands on ground which is covered with débris derived from



the rocks above it, including both kinds of limestone; Idalian beds are, however, exposed here and there *in situ* among the masses of débris.

No wide anticline, such as is indicated in Dr. Bergeat's section, was observed by us at Lapithos, but near the path above Karavas a curious intercalation of beds was seen; a mass of Kythraean sandstone and conglomerate, much flexured, being faulted against shaly limestone (Lapithos Beds) on the southern side, and succeeded on the northern side by another tract of the shaly limestone with an intrusion of igneous rock. Here also it was noted that the shaly limestones contained many flint-bands of 6 inches and less in thickness.

We now come to the question of age which Dr. Bergeat has assumed to be Eocene; but noticing that he had not apparently been able to ascertain what species of *Nummulites* were represented in the rock he found, we wrote to ask whether such identification was not possible. In reply Dr. Bergeat informed us that the fossils were only to be seen in section, and were not easy to determine, but he very courteously sent us his slide of the rock. This we submitted to Dr. Hinde, who reports that, though the structures are not well shown in the siliceous rock, some of the forms may be *Nummulites*, others are certainly *Orbitoides*, while some are probably *Amphistegina*. This association might be Eocene or might be Oligocene; on the whole, however, having regard to the stratigraphical position of the beds, we are inclined to

agree with Dr. Bergeat, and to refer the Lapithos Beds to the Eocene system.

We cannot follow Dr. Bergeat, however, in assuming that there is a break between the Lapithos Beds and the older limestones; discordant dips are no evidence of a break, and can be accounted for by faults. Hence we think that his discovery makes it possible that the compact limestones are Eocene and not Cretaceous; further, it suggests that the Kythræan Series, which, in common with older observers, we had referred to the Eocene, may not be of earlier than Oligocene age.

CHAPTER III.

KYTHRÆAN SERIES (UPPER EOCENE OR OLIGOCENE?).

ALONG the flanks of the Kyrenian mountain range, both on the north and south sides, from the extreme north-eastern end of the Carpas to the neighbourhood of Cape Kormakiti, and again on the southern and western slopes of the central Troödos range, occurs a formation consisting of sandstone and shales, to which Gaudry gave the name of "Macignos."

In adopting this terminology Gaudry followed the example of the Italian geologists, who have applied the term to a similar formation which is found in many parts of Italy. It appears to have had reference originally to the physical character rather than to the mineral composition of the rock, but has since come to be used in reference to a micaceous sandstone found in Tuscany and elsewhere.

Russell, on his part, adopted the word "Konnos" from the vernacular, but he was in error in supposing that the term was applied to these beds exclusively; it is employed throughout Cyprus, principally by well-sinkers, in describing any argillaceous deposit wherever encountered, and, from the nature of its composition, is held to be, as no doubt it is, an impermeable and non-water-bearing stratum. Hence it is that, in searching for water, well-sinkers cease their operations as soon as "Konnos" is met with.

These beds attain a great development along the southern side of the Kyrenia Mountains, and especially in the neighbourhood of Kythræa, and hence (as already stated, p. 7) it has been considered convenient to call them the Kythræan Series. Since the British occupation the country in the neighbourhood of Kythræa and Dikomo has come to be known as the "Hummocks," a term which, however unscientific, conveys a fairly correct idea of the wave-like undulations of the district to which it is applied.

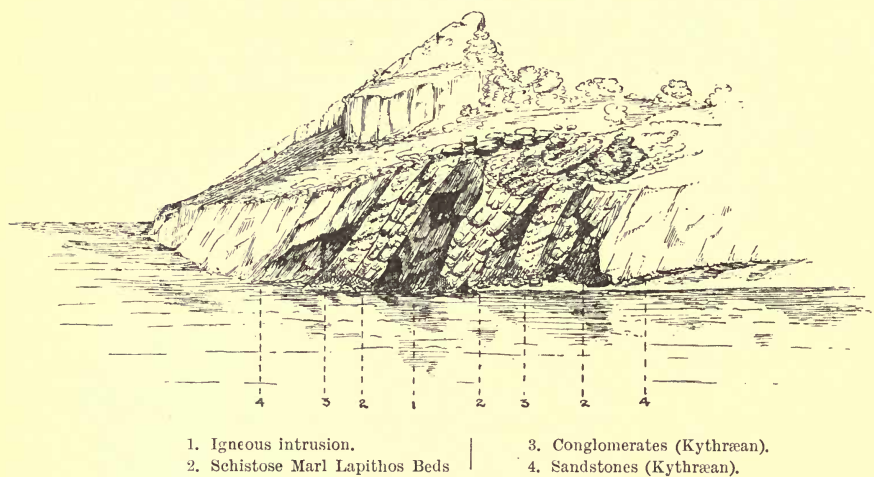
The lowest beds of this series are breccias and conglomerates, but the greater part of it consists of regularly bedded compact calcareous sandstones, brownish, grey, or greenish-grey in hue, while at the top are greenish-grey marls.

The breccias consist mainly of angular fragments of the Trypanian limestones with flints derived from the same formation. They exhibit a variety of hues according to the coloration of the component limestone fragments, and sometimes many tints of blue, pink, yellow, brown, and white are combined in one mass. Good exposures of these breccias can be seen near Skasmata, near Vasilia, and at the castle of St. Hilarion. The cementing material, both of the breccias and conglomerates, is generally, if not invariably, siliceous.

The position of the Kythrean breccia and sandstone at the western end of the Kyrenian range is shown in Fig. 2.

FIG. 2.

View of Skasmata Peak.



1. Igneous intrusion.

2. Schistose Marl Lapithos Beds

3. Conglomerates (Kythrean).

4. Sandstones (Kythrean).

The conglomerates of this series are found to occur in the neighbourhood of the Trypanian limestones, on the slopes of and towards the axis of the Kyrenia Mountains.

They vary in thickness from 2 or 3 feet to 10 feet or more, and are principally seen where gaps in the mountain range occur. They are well exposed in St. Catherine's Pass, where the public road crosses the Kyrenia Mountains between Nicosia and Kyrenia, again near Kythrea Spring, and also in the Akanthou Gap to the north of Lefkoniko. They are also well developed on the northern slope of the mountains to the east and west of Akanthou.

In St. Catherine's Pass they are exposed immediately under Templestowe House, where they attain great hardness, and where the constituents are frequently of large dimensions, but all are water-worn down to the smallest particle. Here the siliceous character of the

cementing element is particularly noticeable, alike in the close texture of the mass as in its hardness.

The presence of these conglomerates is not revealed at all points along the length of the range, and their occasional absence is probably due to faulting. They usually rest on or against the Lapithos Beds, but are sometimes in contact with the igneous rocks, and whenever they are present it is clear that they underlie the Kythræan Series, coming between them and the Trypanian limestones.

Above the conglomerates come the bedded felspathic grits or sandstones which form the mass of the formation, and on the southern side of the Kyrenian range these present a series of billowy undulations like a succession of great ocean waves suddenly arrested and congealed. Some of the beds consist of hard gritty sandstone, while others are soft and shaly, and as the latter have been deeply weathered and washed away by the action of rain, the hard beds stand out as a succession of salient ridges.

In places they rise into hummocks or hills, and the beds are considerably flexured. On the slopes of the mountain range the dips are high (from 40° to 60° , and even more), but southward, toward the plain, the dips are less and the curvatures lower and wider. Mr. Russell, alluding to this formation, mentions the apparent unconformity at its base, and suggests that the reason why the basal breccias and conglomerates of the series are not always encountered is because of the prevailing inward dip of the sandstones on the south side of the range. This, however, does not seem quite a satisfactory or complete explanation, for even if the beds were inverted we should expect a regular outcrop of the conglomerates. We think that the boundary in these cases is a line of fault.

In some places igneous rock intervenes between the two formations, and such cases are also suggestive of faults which will be planes of weakness along which the intrusive material may have made its way.

Another suggestive fact is the existence of many springs along the same line of country, and these springs often discharge a large volume of water, as near Kythræa, Vasilía, Larnaca-tis-Lapithou, and elsewhere. They always issue from the lowest members of the Kythræan series, either from the conglomerates or from the limestone breccia, as in the case of the spring at Sina monastery above Vasilía.

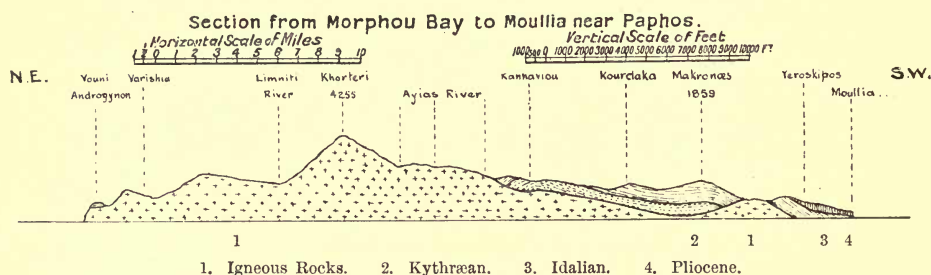
Besides the main outcrops to the north and south of the Kyrenian range and their extension north-eastward into the Carpas promontory, the Kythræan sandstones reach the surface again in several places to the south-west of the central volcanic region. In this district, however, they do not present a continuous outcrop, but are only exposed in

isolated tracts where the overlying Miocene marls and chalks have been removed by erosion.

At Pendakomo, not far from Cape Dolos, on the southern coast, there is a small outcrop of this series, where they appear of a slightly different character, being composed of dark, lustrous sandstones, divided by bands of calcareous shale. In the neighbourhood of Jelajara an extensive area, about 8 miles in length, is occupied by the same lustrous-looking sandstone, but here it is only occasionally accompanied by the calcareous bands.

Again, in the neighbourhood of Phyti and Ayios Dimitrianos is another exposure about 6 miles broad, extending from the valley of the Ayias River westward to Simou and Evretou. Here also sandstones of a similar character are met with, and here again they are interbedded with calcareous shales and marls. The northern border of this tract is in contact with the igneous rocks of the Khorteri range.

FIG. 3.



There are frequent outcrops of these sandstones at several spots in the Acamas, the most noticeable being in the neighbourhood of Akourso and to the west of Polis, near Neochorion.

The same formation is met with in isolated spots, and sometimes over such small areas as to render their identity doubtful. Among these are the outcrops near Pseuda and Paralimni, but the latter occur among masses of calcareous compact marls which have themselves undergone change so as to become sub-crystalline and slightly magnesian.

Wherever they are represented by this dark compact lustrous sandstone there is reason for assuming that the alteration is due to the influence of seen or unseen igneous masses, for it is noticed also that in the same neighbourhoods the Idalian marls have also been changed in appearance, though not always in character. Yet nowhere among the masses met with in the northern part of the island, and where the Kythraean sandstones are more strongly developed, have any traces been observed of a similar alteration even when they are met

with in close proximity to the igneous rocks. On the other hand, however, in the Paphos district the former are almost always attended by the igneous rocks, as though the latter immediately underlay the former, and at their intrusion brought with them small portions of the sandstones.

Although the Kythraean Beds dip southwards beneath the Nicosian and Mesaorian plain, they do not emerge again on the northern slopes of the Olympian Mountains, but are apparently cut through below the Idalian Series by the uprise of the igneous rocks (see section Fig. 4). The only spot where there are indications along this line of the presence of these beds is near Pseuda, west of Larnaca.

There is throughout the Kythraean series an entire absence of any fossil remains, although diligent search has been conducted repeatedly wherever the formation is met with in the great developments of the northern sides of the central plains and among the outcrops in all parts of the island.

Gaudry's description of them as corresponding with the Macignos of Italy would appear to place them in the great series of the Vienna sandstone or Flysch, which is known to extend into Greece and Asia Minor. Possibly they represent the upper part of the Flysch formation, and may be classified as belonging to the Oligocene Series.

Gaudry estimated the thickness of this series as about 2000 metres, which is equivalent to about 6500 feet, but it is doubtful if he made sufficient allowance for reduplication by flexure: indeed, he only speaks of the high dips near the Kyrenian range, and does not seem to have realised the lesser flexures at a distance from that axis. Russell, however, has remarked on the frequency of these undulations, and our own view is that the Kythraean Series does not exceed 2000 feet in thickness, and may not be more than 1500.

The Kythraean and Idalian Series are conformable to one another, but the passage between them is not always a gradual one. Sometimes, and especially in the north-western part of the island, the transition is rapid, as, for instance, may be seen near Kyra and Agia Marina; here the Kythraean sandstones rise abruptly to form the conspicuous hill which, at its south-eastern corner, is known as "Kokkinokremnos." The beds forming this plateau dip to the north, and are covered unconformably by an outlier of Pliocene conglomerate, but on the southern slope they must curve over so as to dip southward, for Idalian (Miocene) beds come in before the valley of the Ovgos River is reached. No outcrop of grey marls was seen, and it is not easy to determine where the boundary between the Kythraean and Idalian runs through this area.

Further eastward, as far as Yerolakko, the change from sandstone

to white marl is more clearly marked, and the boundary is easily drawn, but north-west of Nicosia it again becomes indistinct. From near Nicosia to the Carpas the passage is gradual, and grey marls intervene between the two formations. As a rule, however, these passage beds are only seen in the valleys where the rivers have scoured out channels for themselves through the surface deposits; for here and there small patches of Idalian marls occur, or of material derived from such marls, as well as large areas of Pliocene tufa and of rain-wash brought down from the mountains.

In the Carpas promontory there is much less to obscure the surface of the formations, and the passage from one to the other can be seen more clearly. Gaudry describes the succession which can be made out to the east of Rizo-Carpasso as follows, in descending order:—

Idalian.

White chalky limestone.

Pale rose-coloured porous limestone.

Grey marl, with beds of white chalky limestone.

Clay, with beds of hard marly limestone.

Kythræan.

Clay, with beds of hard calcareous limestone.

Sandy clays.

Sandstones, greenish or greyish.

The discovery of small tests of *Globigerina* in two of the slides cut from the Macignos (see Appendix II.) is interesting for two reasons: first, as proving that these deposits are really of marine origin; and, secondly, as serving to show the intimate connection between them and the foraminiferal limestones of the succeeding series.

CHAPTER IV.

THE IDALIAN SERIES (OLIGOCENE AND MIOCENE).

THIS series includes the white chalky marls and limestones which extend over nearly half the area of the island, and form such a striking feature in the scenery of Cyprus that white chalks are as characteristic of Cyprus as marbles are of Greece. By Gaudry they were termed "The White Marls," but Russell suggested the more distinctive name of *Idalian*, having been struck by the development round Dali (the ancient Idalia), and this name we have adopted.

Both Gaudry and Russell include the gypsum beds in the "White Marl" series, and the former says that they are intercalated with beds of white marl, though he also states that the white marls are often separated from the "Macignos" (Kythrean) by greyish-green marls. So far as our experience goes, the beds of gypsum and selenite only occur in these lower argillaceous marls, which form a distinct subdivision of the Idalian series, and may be from 300 to 400 feet in thickness.

It is true that outcrops of the grey marls not unfrequently occur within the area of the white chalks, but in our opinion this is due to their being brought up by anticlinal flexures, and to the removal of the superincumbent chalky beds. These gypsiferous marls are generally of a greyish-green colour, but are sometimes pale-yellow or buff-coloured. No fossils except Foraminifera have yet been found in them, but from their relative position so far below the beds with *Aturia Aturi*, one may refer them to some part of the Oligocene Series.

The central and thickest portion of the Idalian Series consists of fine compact chalky marls, chalky limestones, and soft siliceous marls in alternating layers, but all appear of intense whiteness in the glare of the Cyprian sun. In these beds occur frequent layers or bands of flint from 4 to 6 inches thick, and varying in colour from pink to buff, grey or greenish; this flint is generally opaque, and often has a waxy lustre, but is sometimes chalcedonic and translucent.

The limestones vary much in character, some are pure *Globigerina* rocks, some are hard, compact, and siliceous, others are tough white

chalks, resembling beds in our own Cretaceous chalk, and some are more or less magnesian; while in some places they have become indurated and tufaceous, probably from the combined effects of solution and evaporation. All these varieties, however, are white, or very nearly white, and it is the whiteness of these rocks which makes the formation such a conspicuous feature in the geology of the island. This whiteness has, without doubt, a considerable influence on the temperature of the atmosphere over the region where they occupy the surface. The glare from the white soil is very painful to the eyes, and the heat reflected from it is often intolerable, especially as in these districts few shade-giving trees have yet been planted. These white rocks are probably from 1000 to 1200 feet thick.

Fossils, other than Foraminifera, are rare in these chalky beds. Gaudry records *Astræa Guettardi* (Defr.) from the neighbourhood of Cape Greco in the south-east; but the rock of Cape Greco is of a peculiar character, and if it does form part of the Idalian Series, it is probably newer than the chalky limestones. He also found *Toxobrissus* (*Brissopsis*) *crescentinus* and *Chenopus pesgraculi* at Phinicia, N.E. of Limassol; a *Lucina* at Leonarissa, and small spines of *Cidaris* at Neta in the Carpas. He also observed "microscopic globules, which are probably a kind of foraminifera," in the white marls of Kilanemo and in the grey marls of Kamaraes; from his description these are clearly *Globigerina*, which we have since found to be abundant in samples of white chalk and limestone, collected near Paralimni (see Appendix II.), Goshi, Lefkara, and other localities.

A few fossils were found near Paralimni while driving a tunnel through compact white chalky limestones, with layers of flint, for the purpose of draining the Paralimni lake. These included a tooth of *Carcharodon megalodon*, and a shell resembling a *Vermetus*, but these may have come from a bed of shelly limestone which overlies the chalk.

Mr. E. H. D. Nicolls, the present Director of Public Works in Cyprus, found that some fossils which had been obtained from a road-cutting, recently made between Pachna and Kissoussa, about 7 miles north of Evdimou. These were forwarded to us, and are now in the British Museum, where they have been identified as *Aturia Aturi* (a kind of Nautilus) and a *Xenophora* of the sub-genus *Tugurium*, closely allied to *T. postextensum* (Sacco).

The fossils above mentioned leave no doubt that the beds from which they came are of Miocene age. *Aturia Aturi* is one of the most characteristic species of the Mediterranean Miocene deposits, and *Brissopsis crescentinus* is an Echinoderm which has only been found elsewhere in Malta and Corsica, where it occurs in beds that belong to the

lowest Miocene stage. It is very probable, however, that all these fossils came from the very highest part of the Idalian series, where it passes into shelly limestones, that are now known to be of Miocene age; hence it is quite possible that the lower part of the series is really of Oligocene age, as it was thought to be when the geological map and its explanation were published.

Since the preparation of the map we have also become aware that there is another set of beds which must be included in the Idalian Series, and must form the highest portion of it. These are certain hard shelly limestones, white or nearly white, and very rough to the touch, from the weathering out of the various organic fragments of which they are composed. So far as we know at present these limestones only occur at intervals in the southern part of the island, and especially in the south-eastern corner near Cape Greco and Cape Pyla. A tract of them extends from Cape Greco to near Paralimni, and they are here coloured as Idalian on the map. Another tract occurs at Cape Pyla, where they have been included in the Pliocene, and are probably overlain by Pliocene a little way inland from the cape.

From the above account it will be seen that the Idalian Series, as we now understand it, falls naturally into three subdivisions of diverse lithological composition, viz:—

3. The shelly limestones.
2. The chalky limestones and marls.
1. The grey marls and gypsum beds.

It may be found more convenient in the future to unite the grey marls with the Kythraean, but until the exact age of the sandstones and the grey marls is ascertained we adhere to the divisions shown on the geological map.

The Idalian Series appears to have originally extended all over the area of the island, and to have covered the whole of the space now occupied by the volcanic rocks. It underlies the whole plain of the Messoria, extending southward towards Larnaca and eastward beneath the Pliocene beds, from below which it rises again in the extreme south-east, and occupies a tract extending from Dherinia and Sotira to Cape Greco. The greatest surface area of this series, however, is on the southern side of the central volcanic highlands. From the neighbourhood of Kophino and Lefkara these beds form a broad tract of hilly country, which borders the whole length of the Troödos Mountains and passes into the Acamas district on the extreme west. In this part of the island they make up the soil of the wine-producing district, and judging from the vigour of the plants, the yield of fruit, and the quality of the wine produced, the ground must be well suited to the cultivation

of the vine. Among the vineyards about Ag. Ambrosios, Mallia, and Vasa, the aspect of the country corresponds, in some measure, with the wide rolling downs and chalk hills of certain parts of England, but the rivers run in deep gorges and through ravines, frequently precipitous and narrow, so that their presence is not detected at a distance.

The Idalian Series has been considerably disturbed and flexured, and round the borders of the great central area of igneous rocks the beds are twisted and contorted, as well as altered and metamorphosed into ochres and Siliceous limestones.

1. *The Grey Marls*.—This set of beds is more frequently seen in the southern than in the northern part of the island, but this fact is probably due to the prevalence of steeper dips and sharper flexures in the north, and to the consequent narrowing of the outcrop in that region, and not to any increase in the thickness of the group toward the south.

The grey marls are not exposed round the border of volcanic rocks, except where the Kythraean beds are also brought up; hence it may be inferred that the volcanic mass is not of the nature of a general uplift, but is more like a huge plug driven up through the earth's crust.

Beds of gypsum, selenite, and alabaster intercalated in these marls are met with in various situations, the principal deposits occurring at Aradippou near Larnaca, at Yermasoyia near Limassol, and at Patriki near Tricomo. Other deposits are found in many parts; the most extensive of these are at Galinoporni in the Carpas, at Gastria and Kamaraes near Tricomo, at Chatos, and at Pyla near Larnaca, in all of which instances the development of selenite is very marked. At Kythraea, Yerolakko, at Ag. Vasilia Hill, and the prominent mass of Lapatsa Vouno near Skilloura and in the neighbourhood of Myrtou, compact and massive beds of fine grained gypsum of straight cleavage are worked for the extraction of paving slabs. Their cleavage is very true and even, and their texture is such that they can be easily cut with a saw. They are underlain by beds of yellow-grey and green-grey marls, and the two others appear to have a synclinal structure.

Similar beds are met with near Pyla, from which neighbourhood also a fine quality of alabaster is procurable, also at Psematismeno where selenite is also present, at several points in the wine country, and at Psathi in the Paphos district. They are, in fact, found more or less closely associated with the grey marls from one end of Cyprus to the other. The compact beds of fine gypseous matter often contain veins and nodules of native sulphur of some purity, but not in such quantities as to render its collection profitable.

The argillaceous member of this series is in strong force in the east of the island near Famagusta, as was proved by a boring for water made near Phreneros, where for a depth of 300 feet nothing but stiff marly clay of a dull blue-grey tint was encountered. The appliances could not carry the boring further, and there was no indication that the base of the formation was being approached. No sign of water was found, but it is probable that a good supply would have been reached if the clay could have been penetrated.

In the north of the island, both in the Kormakiti district and in the Carpas promontory, these grey clays are a prominent feature, though in the intervening tract both to the north and south of the Kyrenian Mountains their outcrop is narrow, and is often obscured by tracts of rain-wash, conglomerate and other surface deposits.

2. *The White Marls and Chalks*.—These beds succeed the grey marls and occupy still larger areas. Where exposed in vertical section they present the appearance of alternating hard and soft layers, these layers seldom being more than a foot or eighteen inches thick, but sometimes the limestones pass into thicker beds, and are then quarried for freestone.

In the neighbourhood of Dali, where they are typically developed, great rounded hills occur in a succession of undulations extending from the neighbourhood of Margi on the west to Athienou on the east parallel with the Idalia or Yalias River. They are here represented by the characteristic tabular beds interstratified with layers of flint and chert.

At Athienou these beds pass into a more massive kind of limestone, of finer quality and less density, and from these beds is extracted a material which has a variety of uses, being very amenable to the tool and capable of being shaped into various utensils employed for domestic and other purposes.

A similar kind of freestone is found near Goshi, to the north-west of Larnaca, and a sample sent from that place by Mr. E. H. D. Nicolls proved to be a *Globigerina* limestone almost entirely made up of the small globular shells of this Foraminifer.*

At Paralimni, in the south-east of the island, a variety of marls and limestones were traversed in making a shaft for some irrigation works there, and these beds are described more minutely in Appendix II.

In the Carpas the limestone in some places among the higher parts of the hills puts on a massive aspect and crystalline structure, as at Pyrgos, the reputed site of the chief town of the ancient kings of

* This *Globigerina* rock has been described and figured in the *Twentieth Century Atlas of Microscopical Petrography*, part iii., 1904. J. R. Gregory and Co.

Carpas. This place is on the upper slopes of the hills three or four miles to the eastward of Yialoussa, and judging from the presence of two unfinished colossal figures of Egyptian design which have recently been found there, it would seem to have been employed at one time for statuary purposes. In the same neighbourhood there is also a tract of highly crystalline saccharoid marble which appeared to be only a more highly altered form of the same limestone, the one passing into the other.

3. *Shelly Limestones*.—As already stated (p. 24), the highest portion of the Idalian Series consists of white shelly limestones, sometimes largely composed of fragments of Echinoderms, sometimes full of *Lithothamnion*, like the rock known as Leithakalk in the Vienna basin. The precise age of these was determined from specimens brought back by Miss Dorothy Bate, whose paper "On the Ossiferous Caves of Cyprus" was read before the Royal Society last year, and the abstract of it was published in the *Geological Magazine* for July.* Two of the caves visited by Miss Bate were at Cape Pyla, a promontory about 12 miles east of Larnaca, and she describes the rock in which the caves occur as follows: "The rock here is composed of Miocene (probably Helvetian) limestone, weathered to a very great extent, and full of marine shells and corals, as well as numerous Echinoids (*Clypeaster portentosus*), also met with in the Miocene limestones of Malta."

The *Clypeaster* was identified by Dr. F. A. Bather, of the British Museum, who states that it is by some regarded as a variety of *Cl. altus*, and that it is essentially Miocene, of Helvetian and Tortonian age. Miss Bate has been kind enough to communicate the following additional particulars about the cliff at Cape Pyla: "The cliffs of the promontory may be described as consisting of two parts, the main cliff rising from sea-level which terminates in a terrace and a second lesser cliff rising from the inland border of the terrace. At the cape itself there was only one sort of rock, and the *Clypeasters* were very numerous from near sea-level up to the foot of the second low cliff line. The actual cape does not appear to have been visited by M. Gaudry, on whose map it has the same colour as the (Pliocene) formation of the surrounding country. To me, however, it appeared to be very different."

By the courtesy of Dr. F. A. Bather we have had the opportunity of examining slides cut from the matrix of the *Clypeasters*. The rock is a rough whitish shelly limestone, being obviously an aggregate of calcareous fragments and small organisms. Under the microscope it is seen to have a matrix of crystalline calcite, embedding many fragments of Echinid tests, pieces of *Lithothamnion* and some of corals, with a few Foraminifera.

* *Geol. Mag.*, Dec. V., vol. i. p. 324 (1904).

The limestone at Paralimni has also the appearance of a white shelly limestone, and a slice of it examined under the microscope shows that it consists of an aggregate of fragments of *Lithothamnion*, Echinoids, Polyzoa and Molluscan shell, with an abundance of Foraminifera. The specimen was obtained from shaft sunk in connection with the irrigation works above-mentioned near Paralimni, where the rock forms a capping to the massive *Globigerina* limestones of the Idalian Series.

It is also to this group of limestones that we are inclined to refer the hard rock which forms Cape Greco, at the extreme south-eastern corner of the island. This promontory is the extremity of a long limestone ridge which extends for a distance of about 10 miles, from Dherinia through Paralimni and Mount Phano to Cape Greco, with an altitude in Mount Phano of 630 feet. The rock of which the cape is composed is a very hard compact limestone, nearly white, but having a tinge of yellow, with a calcified and semi-crystalline appearance on fracture, so that it differs somewhat in general aspect from the limestones above described. It is also remarkable in containing many casts of corals, Gastropod and Lamellibranch shells, which, however, are not in a promising condition for the determination of species.

Gaudry identified one of the corals as *Astrea Guettardi*, a species which occurs both in Oligocene and Miocene limestones,* and he regarded the rock as simply a variety of the "White Limestone" or Idalian Series. Unger and Kotschy, however, obtained other specimens and submitted them to Reuss, who determined the corals as belonging to the genera *Favia* and *Stylina*, and thought they indicated a Cretaceous or Upper Jurassic deposit. Finally corals were obtained here by Professor A. Bergeat and examined by Dr. Schaffer in 1892, who referred them to the genera *Diplocenia* and *Cryptocenia*, and considered the rock to be of Upper Jurassic age, a view accepted by Professor Bergeat.

From the above it will be seen that everyone who has examined corals brought from Cape Greco has referred them to different genera, and only Gaudry ventured on a specific determination. It is probable that few of the corals are in a condition that permits of even generic identification with any degree of certainty.

Specimens of the Cape Greco limestone were obtained, and a slice cut from one of them shows that, though the rock is much calcified, its structure is by no means destroyed, and that it consists largely of recognisable fragments of coral, shells, and *Lithothamnion*. Dr. Bergeat

* This species, now referred to the genus *Heliastrea*, occurs in the coralliferous limestones of Castel Gomberto (Vicentin), which are referred to the higher part of the Turgian, and in beds of the same age in Sicily, according to Seguenza. But in Cilicia it was found by Tchibatcheff in association with *Clypeaster altus* and *Ostrea crassissima* in beds of Miocene age. (See Schaffer, *Jahrb. K.K. geol. Reichsanstalt*, vol. 51, p. 49.)

has also been kind enough to send us his slide of the coralliferous rock which he brought from the same place, and this proves to be less altered, containing not only corals and *Lithothamnion* but Foraminifera, which have been identified by Dr. G. J. Hinde as chiefly *Orbitoides*, with probably some *Amphistegina*. Dr. Hinde also agrees with us in the opinion that the rock greatly resembles the limestones of Paralimni and Cape Pyla in microscopic structure, and that it is probably of Tertiary age.

To the courtesy of Dr. Bergeat also, we are indebted for the opportunity of examining a slice of a limestone from Limni, near Polis, at the other extremity of Cyprus, and this proves to be a limestone of similar type to that of Cape Greco, consisting of organic débris set in a matrix of clear crystalline calcite. *Lithothamnion* is the most abundant constituent, together with pieces of shell, coral, and echinid plates, with a few Foraminifera, though no *Orbitoides* were to be seen.

The conclusion from the facts above recorded is that the Globigerina chalks are surmounted by a series of shallow-water shelly limestones of Helvetian age, and that these rocks will be found to occur at many places in the southern part of the island.

A few isolated masses of a similar crystalline limestone occur near Stavrokono, in the Paphos district, and the junction of the Miocene chalks and shelly limestones seems to have been traversed by the road cutting near Pachna before-mentioned, where both chalky limestone with *Aturia* and a shelly limestone containing pellets of the chalk were traversed.

The Koronia Limestone.—Along the northern border of the central volcanic area and chiefly occurring as outliers resting on the igneous rocks, are certain limestones which we have mapped as belonging to the Idalian Series, though not without a suspicion that they may be of Pliocene date.

The rock is a magnesian limestone—white, massive, semi-crystalline, and slightly concretionary. The following is an analysis of a specimen taken from Koronia Hill:—

Moisture	8·24
Insoluble Silica	1·48
Soluble Silica	·95
Calcium Carbonate	69·03
Oxide of Iron and Alumina	4·81
Magnesium Carbonate	15·49
	100·00

It will be seen that the limestone is fairly pure, with only about $7\frac{1}{2}$ per cent. of impurities (silica, clay, and iron), and that the percentage

of magnesium carbonate is high, though not sufficient to make the rock a dolomite. The bedding of these masses appears to be nearly horizontal, though not well developed, and the planes which look like bedding may in some cases be joints. No clear exposure of the limestone in contact with igneous rock has been observed, so that we cannot say whether its peculiar characters are to be attributed to such proximity, but in some places at least red and yellow clays appear to intervene between the two.

Nothing of the nature of a fossil was found in this limestone, and whether it be of Miocene or Pliocene age, it is quite different in its lithological characters from any bed belonging to either series in other parts of the island.

The most westerly of these patches of magnesian limestone is on the hill called Pilafi-tou-hoja, near Cape Askas, and there is another at Vouni; a larger tract is found on the hill east of Ambelikou, whence it extends intermittently across the valley of the Xeros Potamos to Phoukassa, a hill to the south-east of Evrykhon, and seems to pass into grey Idalian marls eventually near Kato Moni. On the hill called Koronia, near Koutrapha, the summit of which is 1057 feet above the sea, there is a conspicuous outlier of this limestone, and there are two others on the hills east of Visakia, at about 1500 feet.

The same limestone caps the tops and northern slopes of the hills called Koroni and Kryadi Vouno, between Kato Moni and Agrokippia, the former rising to a height of 2140 feet and the latter being little less. On the south side of Koroni a deposit of red-brown and yellow earth seems to intervene between the andesite and the limestone, but on the northern slope and on that of Kryadi the limestone seems to pass into the marls of the Idalian beds.

In the deep gully of the stream near Politiko there is a curious section, a horizontal platform of limestone resembling that of Koronia overlying a mass of coarse sandstone and gravel, beneath which, on the southern side, are seen the grey marls of the Lower Idalian, while on the northern side the gravel seems to thin out beneath similar Idalian marls. Such a collocation of beds is unique, and hardly explicable except on the supposition of landslips, but even that will not explain the horizontal superposition of the limestone on the gravelly sandstone, unless both are Pliocene.

Ochres.—The grey marls of the Idalian Series have in many places been converted into yellow and brown ochres at their contact with the igneous rocks. Beds of this material have been worked at Mavrovouni and at places to the north of Limassol, the product being known under the trade name of "Terra umbra."

CHAPTER V.

IGNEOUS ROCKS.

THE igneous rocks which occur in Cyprus appear to be mostly, if not entirely, of one age, and to have been intruded during the interval between the formation of the Idalian (Miocene) and the Nicosian (Pliocene) formations. The former, where they come in contact with the igneous masses, exhibit the usual phenomena of contact-metamorphism, while the latter pass undisturbed and unaltered over the surface of the igneous rocks. It will therefore be convenient to pause here in our description of the sedimentary rocks, and give some account of the igneous rocks which have been thrust up through the formations we have already described.

Igneous rocks occupy a large area in the central part of the island, extending continuously from the western coast between Morphou and Khrysokhou bays to within 6 miles of Larnaca on the east. They form a mass of mountainous ground which has a length of about 60 miles, with an average breadth of 17 or 18 miles. Patches of similar rocks crop out both to the east and west of this main mass.

Smaller tracts and bosses of igneous rocks also occur along the whole length of the Kyrenian Mountains. In this region it is only the Trypanian and Kythraean rocks which are altered by the igneous intrusions, but in the Carpas, east of the main range, near Eptakomi and Platanisso, there is a long tract of igneous rock which affects the Idalian beds of that area. Hence it seems probable that all the intrusions are of the same age.

At the same time it must be remembered that the lower part of the Kythraean Series is almost wholly made up of volcanic material, which was either the product of contemporaneous eruptions, or was derived from pre-existent rocks (see Appendix II.). Consequently it is possible that some of the intrusive masses in the Trypanian area may be of Eocene age, especially as syenite, liparite, and quartz-felsite have only been met within that area.

As regards the mineral characters of these igneous rocks, Gaudry described them as belonging chiefly to the "Serpentinous and Ophitic"

groups, but his terminology is antiquated, and there are certainly many rocks in the igneous areas which would not now be included in either of these classes.

A much more accurate and detailed account of the igneous rocks of Cyprus has been given by Professor A. Bergeat in a paper already mentioned. By him the following different varieties of rock were recognised :—

<i>Diabase</i>	consisting of	plagioclase, quartz, and hornblende.
<i>Gabbro</i>	„	plagioclase and diallage (with or without olivine).
<i>Wehrlite</i>	„	pyroxene, diallage, and olivine (serpentinised).
<i>Serpentine</i>	„	bastite and serpentine.
<i>Andesite</i>	„	plagioclase and augite (with or without quartz).
<i>Liparite</i>	„	a felspathic ground-mass with crystals of quartz, sanidine, and biotite.
<i>Trachyte</i>	„	orthoclase, plagioclase, hornblende, and augite.

The few specimens which were brought away from Cyprus recently were examined by Dr. J. J. H. Teall, who has recognised the following rocks :—

<i>Augite-syenite</i>	consisting of	orthoclase, augite, and biotite.
<i>Quartz-felsite</i>	„	orthoclase and quartz.
<i>Olivine-dolerite</i>	„	plagioclase, augite, and olivine.
<i>Basalt</i>	„	plagioclase and augite.
<i>Augitite</i>	„	augite and magnetite in a glassy base.
<i>Liparite</i>	„	(as above).
<i>Serpentine</i>	(after an olivine-enstatite rock).	

For the purposes of this memoir it will suffice to point out the localities where each of these rocks has been found without entering deeply into details of their microscopic structure, for which the reader is referred to Professor Bergeat's paper and to manuals of Geology.

Diabase.—This forms three large tracts in the central part of the Troödos range. The first of these includes the mountains west and north-west of Mount Troödos (Khionistra) around the villages of Kykkou, Prodomo, and Mandria; the second is the mass of the Adelphi range, including the mountains of the Adelphi, Papoutza, and Machera; the third is the mass of Stavro Vouni, or the Mountain of the Cross, west of Larnaca.

Professor Bergeat states that these diabases consist of a plagioclase like auorthite, uralitised hornblende and quartz grains; it may con-

sequently be called uralite-diabase. The rock is generally fine grained, and often shows ophitic structure under the microscope. The plagioclase is seldom fresh, and is often changed into saussurite. At Kionia, near Machera, the diabase contains a bright-green variety of augite. Accessory minerals are magnetite and epidote.

Gabbro, Wehrlite, etc.—The summit of Khionistra, *i.e.* Troödos, and all the southern and eastern part of the mountain appear to consist of a complex of the gabbro group of rocks. According to Professor Bergeat the summit consists of wehrlite, the southern slope of gabbro, the northern and eastern of serpentine rocks; while on the western slope, near the peak marked 5782 on Kitchener's map, he found a pure diallagite or diallage-rock. A specimen taken from near the top of Khionistra has been identified by Dr. Teall as serpentine after olivine-enstatite rock.

Rocks which are probably gabbro were recorded by Gaudry at Evrikou north of Troödos, at Agios Nicolaos in the Acamas, and near Akourso in the south-west.

Serpentine.—Besides the outcrops on Mount Troödos, there is a considerable area of serpentine round Phinicia, north-east of Limassol, and all the isolated exposures of igneous rock in the south-west of the island appear to consist of serpentine, *i.e.* those near Agia Varvara and Marathonta, east of Ktima, and those near Peyia and Lara. There is also serpentine at Eptakomi in the Carpas.

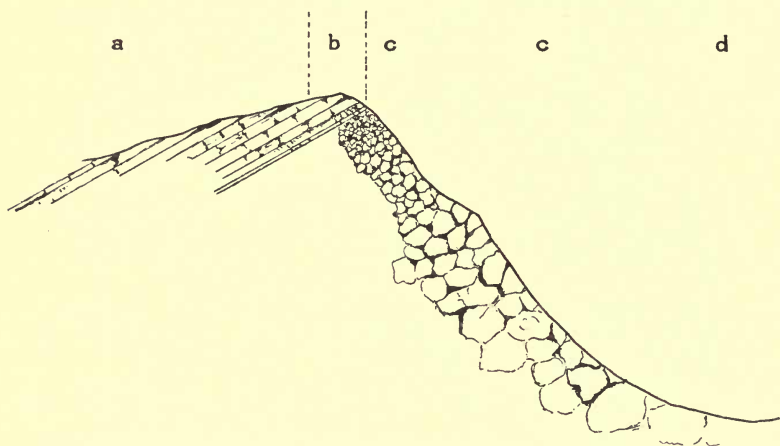
Quartz-andesite.—This seems only to occur in the isolated volcanic tract of Stroullas, north of Larnaca. Unger described the rocks here as Quartz-porphry, but Professor Bergeat found the felspar to be plagioclase, generally forming a ground-mass, in which quartz crystals are scattered; but the felspar is often saussuritised, and there are ferro-magnesian minerals, which seem to be altered augite. The general colour of the rock is reddish or brownish-grey.

Andesites.—Professor Bergeat found a tract or zone of andesite all along the outer part of the Tillyria district, from near Polis on the west round by Yalia and Pomos to the neighbourhood of Lefka. These rocks are all of a green colour from the presence of chloritic and delessitic minerals, the original constituents being much decomposed, so that saussurite and zeolites have been formed from the felspar, and chlorite minerals from the augite. Another tract of the same kind of rock occurs round Lithrodonda.

Another type of andesite forms the eastern border of the central volcanic region by Alambra, Lymbia, Agia Anna, and the eastern slopes of Stavrovouni. This is a red-brown amygdaloidal rock, which might apparently have been either an andesite or a basalt, both felspar and augite being much decomposed, and the latter often replaced by

aggregations of calcite, secondary hornblende, and oxides of iron. Similar amygdaloidal rock occurs in the Carpas, near Platanisso, and also at certain points in the Kyrenian Mountains.

FIG. 5.



Contact between Andesite and Miocene Limestone near Alambra (from Bergeat.)

- a = White brittle Limestone.
 b = White baked Limestone containing Hornstone and Agate.
 c = Andesite breccia (? jointed blocky andesite.)
 d = Compact Andesite.

Basalts.—These occur chiefly in the Tillyria district at the western end of the main volcanic area. They are much decomposed and veined with calcite, and are frequently vesicular with geodes of calcite in the cavities. One specimen collected in this district has been identified by Dr. Teall as an augitite, a rock of the magma-basalt family, allied to limburgite, but without any olivine.

Syenite has only been found in the intrusive mass which is traversed by the Panagra Valley at the western end of the Kyrenian range; it was identified by Dr. Teall from a slice cut from a specimen recently brought home, and he found it to be an augite-biotite-syenite.

Quartz-felsite, or *Rhyolite*, is another rock which has only been found at one place, namely, near Pentedactylos, in the centre of the same range; it is a white variety.

Trachyte, consisting of a crypto-crystalline ground-mass, with crystals of hornblende, augite, orthoclase, and plagioclase, has been recorded by Professor Bergeat from a point between Eptakomi and Platanisso in the Carpas.

Liparite occurs at several places in the Kyrenian range, and seems generally to consist of a felspathic ground-mass embedding crystals

of quartz, sanidine, and biotite. It occurs in the Panagra Gorge, and near Kythraea, as well as in blocks on the surface south of Buffa-vento.

In the andesites and basalts zeolites of several kinds are abundant, sometimes filling vesicular hollows, sometimes lining the cracks and joints. Gaudry mentions analcime and mesotype as the commonest, but also reports stilbite at Kinousa, east of Polis, henlaudite at Lythrodonda, hydrolite or gmelinite at Pyrgos and Forni.

The decomposition of the serpentines and other rocks has given rise to some other peculiar products, such as several kinds of iron ores, or ferruginous earths, as well as the green earth which is known as *terra verte* (see p. 64). These products have imparted both to the rocks and the soils of the volcanic region a brilliant and variegated tinting, delighting the eye with landscapes of red, purple, green, and golden-yellow hills, which, seen in the light of the Cyprian sun against a background of clear blue sky, form pictures of truly Oriental colouring. In many places, too, the unequal erosion and disintegration have sculptured the rocks into remarkable forms, resembling ruined walls, bastions, and battlements, which add greatly to the picturesqueness of the scene. Mount Machera and Stavro Vouni are conspicuous examples of such weathering.

The igneous rocks have also produced some remarkable metamorphic changes in the neighbouring sedimentary rocks. Thus in the northern mountain range the compact Trypanian limestones have been changed from their natural dark grey hue to white, red, or green, and have in places been converted into a schistose rock. In similar situations the Kythraean sandstones take on a dark lustrous appearance, and pass into the condition of lustrous grey-green micaceous schists, often traversed by a network of quartz veins.

A special accompaniment of this metamorphism is the formation of jaspers and jaspideous masses, both in the igneous and the sedimentary rocks. This jasperisation, however, may have been rather a sequel to the metamorphism than an actual result of igneous intrusion. In other words, it may be due to the subsequent uprise of hot waters containing silica in solution, and may thus be attributable to the geyseric and solfataric stage of volcanic activity, like that which is so conspicuous in the Rotorua region of New Zealand.

The jaspers are generally heavy opaque rocks of bright red or yellow tints, and the colours so exactly resemble those of hæmatite and limonite as to suggest that they have been formed by the silicification of masses and veins of these minerals, or of the ochreous marls produced by the antecedent metamorphism of the miocene deposits. In some places, however, black jaspers are met with, as if coloured by oxide of man-

ganese, and sometimes they are green, as if from the silicification of green earth (*terra verte*).

Gaudry specially mentions the district of Mavrovouni (north-east of Larnaca) as affording good opportunities of studying these jaspers and the manner in which they seem to merge on the one hand into the igneous rock, and on the other into the ochres and Miocene marls. The section seen at one exposure is given by him as follows:—

4. White marl containing yellowish-brown flints.
3. Yellow ochre in beds alternating with layers of thermantide and jasper.
2. Red, black, grey, and yellow jaspers.
1. Ophitic diabase.

The promontory of Acamas and the district of Akourso, both in the extreme west of the island, are also excellent places for the study of contact phenomena and of jasperisation.

In the northern chain there is a good exposure south of Klépini, where a small tract of igneous rock penetrates the Trypanian limestones, which are altered near the junction into grey and red schistose limestone with intercalations of red and green jasper. A similar section is visible near Platanisso in the Carpas.

CHAPTER VI.

PLIOCENE AND PLEISTOCENE.

THE deposits comprised in the more recent formations, namely, those of the Pliocene, or Later Tertiary and the Pleistocene or Quarternary strata, are confined, for the most part, to the plains of the centre of the island and to tracts bordering the coast-line. The Pliocene rocks consist chiefly of calcareous sandstones with subsidiary beds of conglomerates, sands, and calcareous tufa; while of the Pleistocene accumulations the more important are the surface conglomerates and breccias, the occasional deposits of Travertine, the alluvial and estuarine deposits of the Messoria, the raised beaches of shelly calcareous sandstone, and the soft shelly sands of Larnaca.

The products of these two periods are readily distinguished from all the older strata, not only by their appearance and component materials, but by the fact that they are unconformable to all the older rocks, and lie in horizontal beds or with very slight inclinations. Moreover, while most of the older sediments appear to have been formed in deep water, and while the Idalian chalks indicate very deep water at a great distance from land, the fauna of the Pliocene deposits is similar to that which exists at the present day in the shallower parts of the neighbouring seas. It is, in fact, quite clear that these later deposits have been formed in shallow water around the two areas of older strata which form the nuclei of the existing island of Cyprus.

But though it is easy to distinguish these later deposits from the older Tertiaries, it is not always easy to separate the Pliocene from the coastal Pleistocene deposits. It is, indeed, very possible that the latter have been largely formed from the erosion of the former, and could only be distinguished by a careful investigation of their small differences and their fossils. Even inland there is often a difficulty in distinguishing the Pleistocene from the Pliocene conglomerates, where patches of the latter are isolated from their associated deposits. For this reason no attempt was made to distinguish the two series by different colours on the map. In the following descriptions we shall refer only to such examples of these rocks as to the relative age of which little doubt can be entertained.

1. Older Pliocene.

Gaudry found reason to think that the Pliocene beds of the Carpas promontory are somewhat older than those of the central and southern districts, because their fossils form a special assemblage, none of the same species occurring in the other districts, and because a smaller proportion of them survive as living species.

We have not been able to collect any additional evidence on this point, nor to examine the Carpas rocks in any detail, so can only accept Gaudry's opinion on the strength of the evidence which he gives.

The shelly limestones and soft calcareous sands of these Pliocene beds form low hills between Agios Symeou and Galinoporni, and near the latter place Gaudry (who seems to adopt the Turkish pronunciation and spells the name Calebournou) noted the following succession:—

7. Thick beds of soft limestone, full of shells, alternating with layers of fine sand.
6. Soft limestones and calcareous sands, with beds of oysters at the base.
5. Yellow calcareous sands.
4. Limestones becoming marly and whitish.
3. Shelly marly limestone.
2. White marly sand passing into white marl.
1. Grey argillaceous marl (Miocene).

He classes Nos. 2 to 7 as Pliocene, and puts the total thickness at about 200 feet, remarking that the beds have an apparent dip of 5° to the north-west. He notes the occurrence of the same white marly sand or silty marl at the base of this series at several places in the Carpas, and also westward along the north coast, as at Davlos and north of Akanthou.

From "Calebournou," Platanisso, and Kilanemo he obtained the following fossils:—

<i>Cidaris Desmoulini</i> , <i>Sism.</i>	<i>Ostrea pseudoedulis</i> , <i>Desh.</i>
<i>Conoclypus anachoreta</i> , <i>Ag.</i>	„ (new sp.).
<i>Megathyris detruncata</i> , <i>d'Orb.</i>	<i>Pecten opercularis</i> , <i>Lam.</i>
<i>Ostrea cochlear</i> , <i>Poli.</i>	<i>Hinnites crispus</i> , <i>Bronn.</i>
„ <i>latifrons</i> , <i>Desh.</i>	„ <i>Dubuissoni</i> , <i>Defr.</i>
„ <i>Boblayi</i> , <i>Desh.</i>	<i>Balanus tintinnabulum</i> , <i>Lam.</i>
„ <i>Virleti</i> , <i>Desh.</i>	

2. Newer Pliocene.

The dominant member of this group has been described as "calcaire grossier" by Gaudry, meaning, doubtless, that it is a rough shelly limestone like that of Eocene age near Paris. Mr. Russell has used the

names "Kyrenia Rock" and "Nicosia Beds" for the particular sandstones that are quarried near these two places; and it may hereafter be found convenient to use the term "Nicosian" as a general designation for the newer Pliocene of Cyprus.

This group of beds covers the greater part of the Messorian plain from the Bay of Morphou on the west to that of Famagusta on the east. Thence it spreads southward to Cape Pyla and Larnaca Bay. There are also considerable areas in the Akrotiri promontory and near Ktima.

The group comprises a variable set of deposits including pebbly sands or conglomerates, yellow calcareous sands and sandstones, glauconitic sands, yellowish shelly limestones, and dark-coloured marly limestone. Of all these the most conspicuous and prevalent are the shelly limestones, which consist almost entirely of organic debris—small worn fragments of shells and other marine organisms, with a small percentage of fine quartz-sand; the whole is really a shell-sand, more or less compacted by infiltrated carbonate of lime. The rock thus formed is sometimes soft and friable, soiling the hands, sometimes hard and durable, so as to form an excellent building-stone. In colour this stone varies from a light yellow to a reddish-brown.

With respect to thickness, this set of beds seems to vary from 50 to 130 feet, and may be more in places.

The commonest fossils are *Ostrea edulis*, *Pecten jacobæus*, *Arca Noë*, *Venus multilamella*, and *Cardita intermedia*.

The beds forming the Kyrenia rock are situated near the town of that name on the northern coast, and, where exposed in a quarry west of the town, are about 30 to 40 feet deep, and generally of an even texture and hardness throughout. They do not cover any great width of ground, and narrow down to thin strips, occurring in isolated patches along the shore-line to the east and west of Kyrenia.

Similar rock is met with in strong force at Ag. Paraskevi, near Nicosia, but here the beds are of variable texture, some being compact and close grained, but alternating with others of a rougher and more friable character; all are buff-coloured, and contain fossil remains.

At Yeri a darker-hued, more compact, harder, and fine-grained material of great durability is met with in considerable quantity, and both here and at Ag. Paraskevi the beds are quarried extensively for building purposes.

In the western part of the central plains near Kyra a similar rock of reddish-brown hue, coarse grained but compact, is quarried somewhat extensively, as it is the best building-stone found in any considerable quantity to the westward of Nicosia, with the exception of Koronia and Phoukasa, in the neighbourhood of Evrychou.

On the high ground between the valleys of the Ovgos and Aloupos rivers there are several outliers of Pliocene; the two western, on one of which Kalokhorio stands, resting on the Idalian, but that west of Agia Marina lies on the Kythraean, and rises in Kokkinokremnos to a height of 1200 feet.

A thin capping of Pliocene limestone and marl also covers the high ground extending from Tremithia Chitlik northward to Karpasia, Myrtou, and Diorios. On Tremithia Hill the limestone is white, granular, massive, and not bedded; it is hard at the top but softer beneath, and is quite different in character from the Kyra and Paraskevi stones, more resembling the Koronia limestone. Its depth varies but seldom exceeds 8 feet, and it appears to lie unconformably on the Idalian grey marls.

There is similar limestone on the hill west of Myrtou, underlain apparently by soft grey marl, for a road-cutting recently made on the slope of the hill traversed such grey marl containing *Ostrea cochlear* in abundance; the specimens were sent over by Mr. Nicolls, and were identified by Mr. R. B. Newton, of the British Museum. We examined some of the marl for Foraminifera, and finding them abundant, the material was sent to Dr. G. J. Hinde, who isolated about sixty forms, and sent us a provisional list. More detailed examination was afterwards undertaken by Mr. F. W. Millett, to whom fresh material was sent, and he has determined no fewer than 186 species, of which a list is given in Appendix III.

This outlier and a smaller one at Kampyli were not inserted on the geological map, because the thickness of the Pliocene was thought to be so small that the ground practically consisted of the supporting rocks. We now think that the Pliocene beds are thicker in places than was supposed, and the Myrtou tract is shown on our sketch map (see Frontispiece).

The most northern of these outliers is on the hill south of Liveras, the top of which is about 3 miles from Cape Kormakiti.

South-west of Nicosia the Pliocene consists chiefly of friable calcareous sandstone, with beds of soft sand and clay, and along the valley of the Pedias River towards Deftera and Aradiou they become gradually more argillaceous, until they pass into fine grey loamy sand and grey-green sandy marl, some of the beds being a true greensand with grains of glauconite. The loamy beds near Deftera contain numerous oyster shells (*O. edulis*).

Gaudry found a fossiliferous exposure of this facies of the Pliocene at Pera, where he obtained a large number of shells from a small outlier of the sands. He remarks on the presence of clay at the base instead of conglomerate, and gives the succession as follows:—

Pleistocene	. Sandy conglomerates with pebbles of "wacke."
Pliocene	{ Very fine grey loamy sands; few shells.
	{ Glauconitic sand, full of shells, 1½ inches.
	{ Grey marl rock, tabular, a few inches.
Miocene	{ Blue argillaceous marl, a small thickness.
	. White marl.

The following are some of the shells which he obtained from the glauconitic sand :—

<i>Turritella subangulata</i> , <i>Bronn.</i>	<i>Fissurella gibba</i> , <i>Phil.</i>
<i>Ringicula auriculata</i> , <i>Desh.</i>	<i>Dentalium 9-costatum</i> , <i>Desh.</i>
<i>Natica helicina</i> , <i>Broc.</i>	<i>Bulla lajonkaireana</i> , <i>Phil.</i>
<i>Nerita proteus</i> , <i>Bonelli.</i>	<i>Donax minutus</i> , <i>Bronn.</i>
<i>Trochus turgidulus</i> , <i>Broc.</i>	<i>Venus multilamella</i> , <i>de Vern.</i>
<i>Ranella marginata</i> , <i>Brong.</i>	<i>Corbula revoluta</i> , <i>Phil.</i>
<i>Cerithium scabrum</i> , <i>Lam.</i>	<i>Cardita intermedia</i> , <i>Lam.</i>
„ <i>crenatum</i> , <i>Defr.</i>	<i>Pectunculus nummarius</i> , <i>Lam.</i>

Round Laxia a bed full of oysters crops out to the surface, and the shells are spread over the flat tops of the soft sandstone hills in vast quantities. In the vernacular these oyster-beds are called "ostrakoudhies." The prevalent species is *O. edulis* var. *edulina*, but some other shells occur.

Eastward and southward there are frequent occurrences of the same friable rock, and near Agios Sozomenos great masses are exposed. The texture is very variable, sometimes it is compact and durable, and at other times it is friable and easily eroded, so that it is not unusual to find cliffs composed of alternating hard and soft layers, the former projecting as ledges beyond those which have yielded to the action of wind and rain.

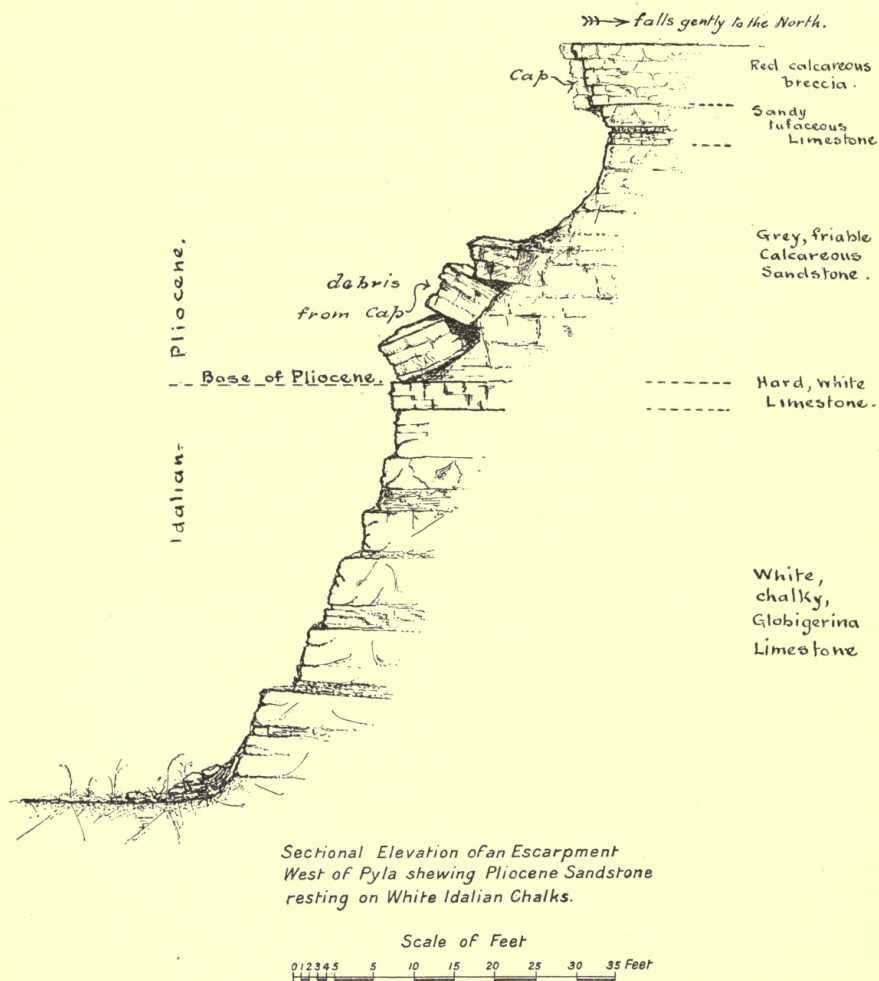
Around Kouklia and Kalopsida dark sepia-coloured sandstones, in massive beds, fine grained and friable, are found. Again, near Vatile and Strongylo there are similar sandstones, but these are finer in texture, lighter in colour, and more friable. Neither of these rocks is durable, and they are easily disintegrated on exposure to the weather.

At Famagusta massive yellowish calcareous sandstones are met with similar in texture and appearance to the Nicosia stone, and the durability of both qualities would appear to be very considerable, to judge from the condition of the numerous medieval buildings at Famagusta and Nicosia which have been built from stone procured from these quarries respectively.

Similar shelly limestones extend southward to the neighbourhood of Pyla and Voroklini, where they form escarpments and are well exposed in several places.

The succession of beds exposed in this escarpment is shown in Fig. 6, where measurements were taken for us by Mr. Nicolls. He also sent

FIG. 6.



specimens of the different beds, which have enabled us to give accurate descriptions of each, and to determine how great a thickness of each formation here comes into the escarpment.

A greater thickness of the Pliocene limestones appears to come in to the south-west, and a good exposure is mentioned by Gaudry as occurring

by a cave or grotto called Mavrospilios which is about 2 miles south-west of Pyla, and he mentioned the following beds:—

	Feet.
Alternations of fine yellow sand and of soft limestone containing pebbles of ophitic rocks	19
Fine yellow compacted sand, <i>Echinolampas hemisphericus</i>	6
Soft limestone with <i>Neithea jacobæa</i>	6

Besides the above, he obtained the following fossils here: *Echinochlamys studeri*, *Spatangus corsicus* (?), *Pecten unicolor*, *P. varius*, *P. squamulosus*, *Ostrea*, and other bivalves. He considers that the total thickness of the beds at this place must be 130 feet.

Pyla itself stands on the Idalian white marls, but the hills to the north and west consist of the yellow Pliocene sands and limestones. Gaudry records an exposure showing the junction of the two formations, and describes the basement bed of the Pliocene as a "coarse-grained limestone, the lower limit of which is marked by a layer of *Lithodomus*."

On the southern sea-board there are no great developments of this sandstone except near Ormidhia, south-east of Pyla, at Akrotiri near Cape Gata, at Ag. Phyla near Limassol, and around Ktima (Paphos).

The Ag. Phyla quarries produce a fine-grained white shelly limestone, compact and durable, and largely employed for building purposes in Limassol and the neighbourhood.

At Ktima the texture is coarse, less compact, and more friable than is usually met with among the coarse-grained descriptions. It is also darker in hue than that of either the Nicosia or Famagusta quarries.

Beyond this instance there is no extent of shelly limestones in the Paphos district except in the valley of the Krysoukhon River, near Skoulli, where a good quality of durable stone is again encountered. The general character of this rock is usually buff, but it is interlaid with bands of greyish sand of fine texture, and the scarps present a striped appearance, alternately buff or grey (see Fig. 7).

Generally speaking, these calcareous sandstones, whether coarse or fine, compact or friable, are massive, their beds lying evenly horizontal, suggesting that little change of inclination has taken place since their original deposition. Sometimes their beds are 20 feet and more in thickness, and at others as little as 2 or 3; layers of conglomerates, sometimes cemented with hard carbonate of lime and at others sandy and easily disintegrated, intervening.

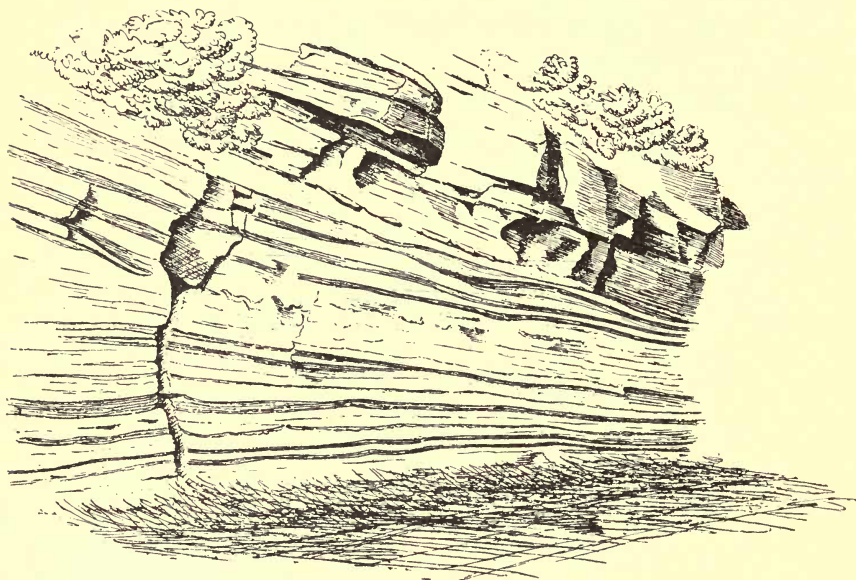
In the areas occupied by these shelly limestones the surface of the beds is often bare of soil, the capstone or uppermost layer being sometimes smooth and even, sometimes deeply pitted or pocked, having a

coating of carbonate of lime, resulting from successive solution and precipitation of the calcareous matter, so that the texture, character, or quality of the rock beneath is unnoticed until the removal of this veneer.

Large areas occur over which an inferior quality of shelly sandstone in beds of variable thickness and texture extends. It often happens that

FIG. 7.

Road cutting near Skoulli, Paphos District.



Calcareous Sandstone with Grey or Grey-green bands.

the capstone of these beds remains in place, but is only a few inches thick with empty spaces below, so that the ground gives out a hollow sound whenever traversed by animals or vehicles; in places this crust has collapsed revealing large cavities beneath. Elsewhere the substratum consists of a calcareous tufa combined with fine pebbles to make a material known as "khavara," the local term for gravel.

In certain parts, as, for instance, about Pergamos, Avgora, Xylophago, Dherinia, and thence to Famagusta; again about Kokkino-trimithia, westward of Nicosia, this crust of inferior sandstone is overspread by a thin layer of reddish-brown loamy matter constituting a soil of considerable fertility well suited to the cultivation of "rovi" or vetches, and potatoes, as well as cereals; its productive power is remarkable as compared with its shallow nature. These localities by reason of the colour of the soil in their neighbourhood are known as the "Red Villages."

CHAPTER VII.

THE PLEISTOCENE BEDS.

UNDER this head are included all the deposits which are of later date than the Pliocene. They may be described under the following heads:—

1. The littoral limestones and pebble beds.
2. The soft shelly sands near Larnaca.
3. The inland surface conglomerates.
4. The cave-earths.
5. The alluvial plains and marshes.
6. Blown sand.

The Littoral Limestones.—These form tracts of varying width between the Pliocene limestones and the existing seashore. Where the slope of the ground is steep the strip of Pleistocene limestone is narrow or absent; where the ground is low the more recent deposits cover wider areas.

As stated on p. 37, it is not always easy to distinguish the Pleistocene from the Pliocene limestones, but in many places they form a distinct terrace bounded by cliffs or steep slopes formed of the older rock; they are generally less consolidated, and the shells they contain are much fresher in appearance as well as being almost all of existing species.

All the low-lying ground near Larnaca appears to be occupied by Pleistocene deposits, extending southward to Cape Kiti and northward to Voroklini. Gaudry mentions an exposure of the harder beds on the coast at "Ridgelia," west of Voroklini,* and describes them as sandy limestones made up of small shells including *Cerithium* and *Pectunculus pilosus* and the coral *Cladocora cæspitosa*; towards the base are layers of pebbly conglomerate. These beds are traceable westwards to Livadia and pass into or below the deposits which surround the salt lake of Larnaca, for Gaudry collected many shells (of which he gives a list) from a spot north of Larnaca, where the succession was as follows †:—

* *Op. cit.*, pp. 37 and 90.

† *Op. cit.*, pp. 37 and 90.

Loamy sand.

Fine sand with few shells.

Very coarse sand made up of shells (*Venus* and *Spondylus*).

Sandy conglomerates with pebbles of hard limestone and aphanite ;
full of shells, including *Strombus coronatus*.

Sandy conglomerates with pebbles of limestone and aphanite.

The salt lake of Larnaca and the deposits around it have been described in another publication,* to which the reader is referred. They consist principally of yellow shelly sands, with one or more beds of marl, and a large number of shells may be collected from these deposits. Gaudry enumerated 88 species of Mollusca, 4 species of *Serpula*, 3 Echinoderms, and the coral *Cladocora cæspitosa*, which occurs in layers and seems to have lived on the spot. There are also many Bryozoa and Foraminifera. It is clear that the salt lake and the other lakes to the south were once connected with the sea and formed one continuous inlet or bay. At a still earlier period in Pleistocene time the sea extended much further inland and covered the ground on which Larnaca stands.

The plain of Limassol presents similar features to those of Larnaca, near Larnaca, and seems to have been formed in a similar way by the silting up of an arm of the sea between the mainland and the promontory of Akrotiri, which must then have been an island. The shelly (Pliocene) limestones of Akrotiri pass northward below sandy conglomerates containing large stones and boulders of limestone, basalt, and other igneous rocks. Similar conglomerates are found to the north and west of Limassol, and between these slopes lies a flat plain with the salt lake in its midst.

Conglomerates, mostly of Pleistocene age, but among which may be some of Pliocene date, spread over large areas in many parts of the island and are sometimes of considerable thickness.

They are invariably composed of water-worn fragments of older rocks, whether of the Igneous, Trypanian, Kythrean, or of the Miocene Series, according to the localities in which they are found. For instance, along the foot of the Kyrenia Mountains they contain pebbles of gabbro, diorite, flint or marble, and in the neighbourhood of the southern mountains they are made up of fragments of the various igneous rocks composing these masses, with pebbles of chert, and the harder fragments of white marl.

In all cases the component materials are water-worn and vary in size ; and in no instance is there any suggestion of a brecciated structure. They are invariably a purely local development. The cementing ele-

* *Quart. Journ. Geol. Soc.*, vol. 56, p. 745.

ment is usually calcareous, but occasionally oxide of iron is present either in substitution of, or combined with, the carbonate of lime. The texture is very variable; sometimes it is extremely hard, but at others it is friable and easily disintegrated, and occasionally the compact masses pass into bands of loose gravel and sand, either fine or coarse, containing little or no trace of any cementing matter.

It is seldom that the conglomerates attain any thickness in the compact or concreted state, but frequently great accumulations, as in the neighbourhood of Koutrapha and over an extensive area in that direction, have been formed of alluvial matter, detritus borne down by torrents from the mountains; and among these, or overlying them, are thin layers or crusts of concreted material as though the old ground-surface had solidified from time to time, and had been subsequently overlaid by further accumulations of detrital matter.

Deposits of this kind are largely developed in the country from Peristerona to the shores of Morphou Bay, and indicate how the rivers have borne down great quantities of gravel, shingle, and boulders from the southern mountains, spreading their burden in fan-shaped deposits over the lower ground.

Such conglomerates are often seen overspreading extensive and conspicuous masses of Miocene marls, as at Arona, at Leondari Vouno near Athalassa, in one or two solitary and conical hills near Pyroi, in a series of eminences north of Athienou towards Agia Kebir, and again at Koroni, near Arsos. The surrounding masses have been removed by erosion, leaving abruptly scarped hills capped with an even layer of conglomerate, which, being more durable, has protected the underlying beds of marl or shale. This feature is reproduced in more modified forms in many parts of the island, and as the mountain ranges are approached it is found that the surface deposits have an inclination corresponding with the slopes of the mountain. These occurrences frequently lead to some confusion in identifying the strata of which the hills themselves are composed, and render the task of mapping an extremely difficult one in some places. But close observation reveals the fact, as disclosed upon the slopes of the hills, that whereas the base may be composed of Eocene or Miocene rocks, the material on the top consists of either tufa, conglomerates, or Pliocene sandstone.

The inclination of these beds might lead one to suppose that it has resulted from the upheaval or depression of surrounding country, but it is more probable that in such situations deposition took place at an inclination corresponding to and identical with the present slopes.

Travertine and Calcareous Tufa.—Deposits of these materials abound on the northern slopes of the Kyrenia Mountains, and principally at Karavas, Lapithos, and at the northern end of the St. Catherine's

Pass below Templestowe. They are made up of successive layers of stalagmitic deposits, and contain impressions of leaves and foliage of plane and alder trees, etc.

At Lapithos the deposits rise one above another in a series of plateaux on which the village has been built, the vertical faces assume a cascade-like appearance, while the internal structure is vermicular. Under Templestowe the public road passes along the foot of a cliff, from the face of which formerly projected a great mass of travertine overhanging the roadway; but in an evil hour the vandal turned his attention to it and destroyed one of the most striking natural features of the neighbourhood.

Cave-Deposits.—Many caves occur in the Kyrenia Mountains, and there are others in the neighbourhood of Cape Pyla; at both these localities ossiferous deposits exist, and explorations recently conducted by Miss Dorothy M. A. Bate have revealed the presence of mammalian remains which have formed the subject of memoirs submitted to the Royal Society by Dr. H. Woodward.* Among these remains are *Hippopotamus minutus* and *Elephas cypriotes*, both hitherto unknown to science, and both pigmy representatives of their respective genera. The cave-fauna, however, does not seem to be a large one, and the only other extinct form of any importance is a new species of genet (*Genetta plesictoides*).

Alluvial Plains.—The most important changes which have taken place during the later part of the Pleistocene period are the silting up of bays and inlets of the sea, and the general raising of the surface all over the inland plains by the accumulations of detrital matter brought down by rivers and floods from the higher parts of the country.

To this process is due the formation of the level tracts of land in the Messoria, now famous for their fertility and given over to the cultivation of cereals, cotton, etc. These plains are all the product of successive rainstorms, and each year increases the accumulation. As the torrents descend the bare mountain slopes they take with them great quantities of fine silt, of great value as a fertilising agent, which are borne in suspension in the water and distributed over the more level areas. For centuries past the flood-waters have been led by human agency through artificial channels over all parts of these plains, and so the burden of the waters has been evenly distributed and the general level of the land has been slowly raised.

Proofs of the progress of this accumulation are not wanting, and perhaps among the best is the case of the old church of Panayia Theotokou, near Asha. The instinct of every primitive race, and the

* *Trans. Roy. Soc.*, 1903 and 1904. (See also *Geol. Mag.*, 1903, p. 241, and 1904, p. 324.)

early Christians were no exception, is to build its places of worship either on eminences or in conspicuous situations; but however prominent a feature this old church may have been in the early years of its existence, it now lies in a hollow some 8 or 10 feet below the surrounding country. In the days of their persecution the Christian communities in Cyprus have excavated churches or chantries in the solid rock and frequently underground, but they did not deliberately build their churches in pits and hollows such as this. Now this edifice bears evidence of Byzantine origin, and may therefore be, so far at least as its foundation is concerned, eight hundred years old. This would yield a mean rate of elevation of the surrounding country of, say, one foot in a hundred years. This rate of progression need not cause alarm.

Further down the Messoria is a causeway, by means of which traffic has crossed the bed of the Pedias River near Prastion for perhaps five hundred years. It cannot be doubted that when built the roadway stood at some considerable height above the surrounding land; yet it is now in parts not more than two feet high or so, and the waterways are closed nearly to the crowns of the arches.

A more recent instance of the great quantity of matter brought down by floods will be found in the case of the Syncrassi Reservoir near Tricomo. The torrent which feeds this is not a large one; it is not often in flood, nor does it drain an extensive watershed; yet in the course of three years the silt accumulated in the bed of the reservoir extended to a depth of six feet, and this included the filling up of large excavations in the soil from which part of the material in the embankment was procured.

There are in several parts of the lower Messoria traces of masonry works, partly, and in some cases completely, buried by the soil, and their presence has only been revealed in the course of excavations connected with the recently constructed irrigation works.

What these old masonry works may have been is difficult to determine at the present day, but it is more than probable that they were dams or weirs connected with ancient irrigation systems which have long since fallen into desuetude and decay; their existence is distinct evidence of the progressive raising of the land-surface by the periodical deposition of water-borne silt.

These instances will show to some extent the enormous quantities of matter which are transported annually from the hills to the plains by the various rivers, and it need not be difficult to believe that in the dawn of history the eastern part of the Messoria Plain did not exist, but formed an inland extension of Famagusta Bay, which has been slowly and naturally reclaimed to become fertile corn-lands.

There is still an extensive area in the neighbourhood of the ancient

city of Salamis which is below sea-level, and though the sea is now excluded by sand-bars, etc., old maps of the fifteenth and sixteenth centuries show that it extended inland for a considerable distance beyond its present limit. Scientific research and excavations have revealed the presence inland above the village of Enkomi of quantities of buried treasure attributed to the Mycenæan pirates, the Vikings of the Levant, who may have made this one of their haunts and the hiding-place of their ill-gotten booty; and indeed it needs no great stretch of imagination to picture this spot a secluded creek, an ideal harbour of refuge.

Blown Sand.—Much of the reclamation of this part of the island may be due to the accumulations of blown sand, which are every year increasing in extent and quantity. This is testified by the more than half-buried state of Salamis, which probably up to the fifth or sixth century of the Christian era was a thriving city, perhaps indeed the most important in Cyprus. Further south on the same sea-board near Varoshia extensive sand-dunes occur which are yearly absorbing more and more of the fertile land and encroaching upon the neighbouring orange groves. The formation of these dunes appears to be due to the high westerly winds of summer, which bring quantities of sand and dust along with them.

Such aerial deposits are not, however, of frequent occurrence. The worst case is probably that of Ag. Irini, and for 5 or 7 miles to the southward, on the shores of the Morphou Bay, at the other or western end of the plains; in this case the sand is thrown up by the sea and carried inland by the prevailing winds. As yet the dunes do not extend continuously for any considerable distance inland, but intermittently their influence is felt near Kapouti and as far inland as 7 or 8 miles from the coast.

Along the sea-board of Tillyria, at Pakkyammos, at Stavromeni, and near Konakia-tou-Pyrgou the same phenomenon is met with, and again at Ronnas and Nankomi in the Carpas, but the drifts are limited in extent.

Much havoc was caused, at one time, on the coast between Limassol and Amathus by blown sand until judicious and systematic tree-planting, undertaken by the Public Works Department, arrested its progress. After a series of experiments, during which a variety of trees were tried without success, it was found that the only one which thrived was a species of acacia (*A. longifolia*), sometimes known as the "Australian Black Wattle." In the course of eighteen months these trees had reached a height of 10 or 12 feet, the trunk being in some cases 10 inches in girth, with vigorous bushy branches through which no breeze fierce enough to convey sand could penetrate. In three years

the drifting of sand was completely arrested, and the public road, which at all times previously had been axle deep in sand for some considerable length, was rendered as free from obstruction as any English turnpike.

At certain points along the coast-line there are indications of considerable changes of outline, and evidence of this can be found in old maps of the fifteenth and sixteenth centuries. One of these, published in 1579 under German patronage, of which a copy is in our possession, shows that the sea extended inland at other places besides the neighbourhood of Salamis, to which reference has already been made. This map had not come into the author's possession when he wrote his paper on the Salt Lake of Larnaca,* and prepared the diagram showing it to have been at one time an arm of the sea; but it is now found that the old map shows an indentation on the coast identical with that constructed from topographical evidence on the spot.

The Department of Agriculture, in digging a well during the year 1902 in the Bamboula marsh at the western side of Larnaca and about a quarter of a mile inland, found at a depth of 7 feet from the surface a thick layer of shells overlying a bed of peaty matter, both of marine origin. Some of the material was sent to Mr. Jukes-Browne, who has been able to identify the following species, all of which are forms now living in the Mediterranean.

- Cerithium rupestre*, *Risso*.
- „ *conicum* (?), *Blainv.*
- „ *strumaticum*, *Locard*.
- Gibbula purpurea*, *Risso*.
- Cyclonassa neritea*, *Lin.*
- Bulla hydatis*, *Lin.*
- Rissoa parva*, *da Costa*.
- Paludestrina* *sp.*
- Cardium edule*, *Lin.* (young).
- Lucina leucoma*, *Turt.*
- Tapes* *sp.* (young).

The peat deposit was considered by Mr. Gennadius, formerly Director of Agriculture of Cyprus, to whom the authors are indebted for the samples, to be a species of *Fucus*, and he believes it capable of being employed as fuel.

These evidences show that, at no very distant period in the past history of Cyprus, the sea extended inland here for some considerable distance, and that the whole of the land on which stands the modern

* *Q. J. G. S.*, vol. lvi., 1900.

town of Larnaca or Scala has been reclaimed from the ocean. The walls of the ancient town of Shittim or Kitium, and of which traces are to be seen immediately to the west of Bamboula marsh, and from which the wood for King Solomon's Temple is supposed to have come, probably abutted on the shore in King Solomon's time.

The salt lake near Limassol is also shown in the same map to be joined to the sea by a waterway on the eastern side opening on to the bay of Limassol. This passage is now closed by accumulated sand and shingle, but at times, when heavy seas are running in from the south-east, the waves break over this bar and so find their way into the lake. Such an event is by no means of frequent occurrence, nor has a distinct breach been made in the barrier at any time during recent years through which the sea has had free access to the lake. There are traces of a former canal with masonry sides joining the lake with the sea, but its history is lost in obscurity.

The deposits of salt in both the lakes at Larnaca and Limassol are worked for commercial purposes, and the supply is far in excess of the demand.

On the western sea-board there are indications of the existence of an estuary into which the Morphou River discharged at a point near the present village of Syrianokhori, but this has been given up by the sea and is now a succession of marshes and swamps.

CHAPTER VIII.

A SUMMARY OF THE PHYSICAL HISTORY OF CYPRUS.

THE oldest portion of the island, and the foundation on which the more recent deposits have been built, appears to have been an area composed of tilted and metamorphosed Cretaceous and Eocene rocks. It is probable that in later Eocene times this area was united to other tracts of similar land in Greece, Asia Minor, and Syria, though Cyprus itself affords no evidence on this point. It is clear, however, that there came a time when this land sank beneath the sea, and that its erosion furnished the materials for the accumulation of the Kythrean breccias, conglomerates, and sandstones. This is the first phase in the geological history of the island.

The subsidence continued till the ancient land-surface was buried beneath several thousand feet of marine deposits and till the water above these deposits also became of a depth to be measured by thousands of feet. This is testified by the Idalian Series comprising beds of pure *Globigerina* limestone like those of Malta, and siliceo-calcareous beds containing both Radiolaria and *Globigerina*, like the siliceous earths of Barbados, which so greatly resemble certain modern oceanic oozes.

This subsidence lasted through the Oligocene and the greater part of the Miocene period, but was succeeded by movement in the opposite direction accompanied by powerful volcanic action. Seeing that the highest ground in Cyprus consists of an extensive mass of igneous rocks which have been forced upward through the formations above mentioned, and seeing that the summits of these mountains rise to over 5000 feet, and in one case to over 6000 feet, above the sea, it seems probable that this volcanic mass is the real nucleus of the modern island of Cyprus, and that it rose above the waves as an island of volcanic rocks, crowned probably by one or more active volcanoes. This must have been its condition during the later part of the Miocene period. (Sarmatian and Pontian Epochs.)

This episode of volcanism and its attendant upheaval caused much compression and flexuring of the strata forming the Idalian and Kythrean Series. It was probably at this time that the great anticline of the Kyrenian range was formed, and there can be little doubt that

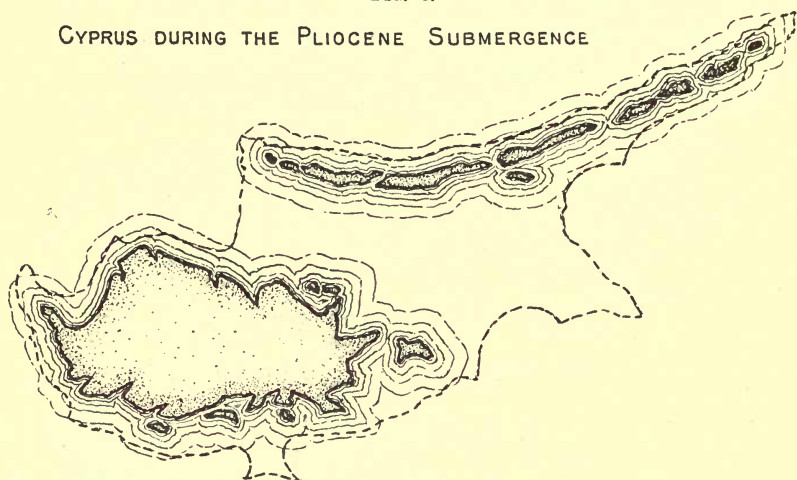
this range was continuous with the Jawah range, which lies between Antioch and Alexandretta in Northern Syria. At this time Cyprus was, doubtless, a part of Asia, united to the mainland both on the north and on the east.

These continental conditions seem to have lasted into the Pliocene period, for no deposits comparable with the older Pliocene of Italy and Western Europe have been found in Cyprus; that is to say, nothing comparable with the Plaisancian of the Apennines and of Liguria or with the Coralline Crag of our country. Such fossils as have been obtained from the oldest Pliocene rocks of Cyprus do not indicate a more ancient epoch than that of the Astien of Italy and our Red Crag.

During this later Pliocene age subsidence again took place, but this time the Cyprian area was only partially submerged, and the sea

FIG. 8.

CYPRUS DURING THE PLIOCENE SUBMERGENCE



Broken Line = Present Coast Line of Cyprus.

around it remained shallow. The subsidence carried this Pliocene sea over and across the Mesorian Plain, and thus separated the highlands of the south-west from those of the Kyrenian range. At this time, therefore, Cyprus was represented by two islands, or by one chief island and a chain of elongate islands to the north-east of it, as suggested in the diagram (Fig. 8). Between and around these islands lay the shallow sea, in which swarmed the various kinds of organisms that have contributed so largely to the formation of the Pliocene deposits.

Once more an upward movement was imparted to this region of the earth's crust, and from the Pliocene sea the plains of Cyprus were raised into Pleistocene land. There is nothing in the relative position of the Pleistocene beds to show that the area of Cyprus was more

extensive in early Pleistocene times than it is now. The fringe of marine deposits around its coast partakes of the nature of a set of raised beaches, and for aught that the geologist could gather from the character and contents of these beaches, they might only mark a stage in the gradual and final emergence of the island. There are, however, grounds for supposing that in early Pleistocene time a very considerable uplift of the whole Mediterranean region took place, raising it to such a high level, in fact, that several bridges were established between Europe and Africa, while the sea space was contracted into two land-locked and isolated inland seas.

One of these connecting land-bridges is believed to have stretched through Malta to Italy, thus accounting for the existence of small species of Elephant and Hippopotamus, whose remains are found in the caves of Malta. The discovery of a tooth of a pigmy hippopotamus in Crete led Professor Boyd Dawkins to think that the whole of the eastern basin of the Mediterranean was included in the area of elevation, and that the land then stood as much as 3,000 feet above its present level.* Professor J. Geikie,† however, has pointed out that it does not need an elevation of 3,000 feet to connect Crete with the mainland of Asia Minor by way of Scarpanto and Rhodes. Reference to the most recent Admiralty chart (1897) shows that an elevation of just half that amount, *i.e.* 250 fathoms, would be sufficient.

The still more recent discovery of mammalian remains in Cyprus by Miss Bate confirms the general truth of the opinion that the whole of the eastern Mediterranean area was raised to a high level in early Pleistocene time. Reference to the same chart shows that the uplift required to unite Cyprus with the mainland is rather greater than in the case of Crete, and would amount to at least 300 fathoms and probably 320 (1,920 feet).

The depth of water between the northern coast of Cyprus and the mainland is everywhere from 500 to 600 fathoms, while that to the east of the island is still greater, ranging over a wide space from 600 to 800 fathoms. It is only to the north-east toward the Gulf of Iskanderun that the sea becomes shallower, and an uplift of 320 fathoms would not do more than raise a certain tract of shallow water in front of this gulf and unite it to the Carpas promontory by a narrow neck of land (see Fig. 9).

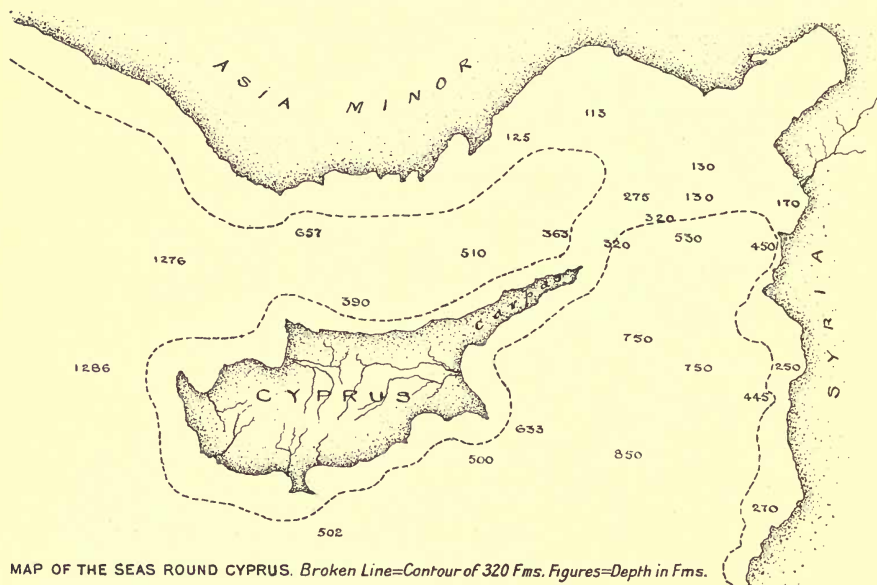
On the other hand, we must remember that a neck of sinking land is exposed to rapid erosion on both sides by the action of the waves, and that such a neck may be broken through and converted into a strait long before continued subsidence would have brought it down

* *Cave Hunting*, by W. Boyd Dawkins, p. 378, *et seq* (1874).

† *Geol. Mag.*, vol. x. p. 50 (1873) and *Prehistoric Europe* (1881).

to the level of the sea. Furthermore, after it had been reduced to a low-water platform by the ordinary action of the waves, storm-waves and strong currents would still continue the erosion, and we know that such erosion extends to a depth of many fathoms. Hence in calculating the minimum uplift which is absolutely necessary to bring about any given land-connection, these circumstances should be allowed for, and the difference of level should be estimated at something less than the actual present depth of the intervening sea. It is concluded,

FIG. 9.



MAP OF THE SEAS ROUND CYPRUS. Broken Line=Contour of 320 Fms. Figures=Depth in Fms.

therefore, that there is no reason for placing the general level of the Mediterranean region in early Pleistocene time at a higher figure than 1,800 feet above that of the present day.

From this state of high elevation the land came down once more, and the raised beaches of the Cyprus coast testify to its having sunk to a somewhat lower level than that at which it now rests. It is possible that this subsidence, or some particular phase of it, is the event which is still celebrated in Cyprus by the annual ceremony of the Kataklysmos. By this subsidence the island was practically reduced to its present limits, for the final movement of elevation has not added greatly to its surface area.

Of the recent and historic modifications of the surface, consisting chiefly in the silting up of lagoons, the formation of sand-dunes, and the accumulations of land-wash and alluvium over some extensive areas, it is not necessary to make further mention.

CHAPTER IX.

ECONOMICS.

THE industrial uses to which the rocks of Cyprus are put are comparatively numerous, although the mineral wealth does not now appear to be great. Philosophers, poets, historians, and travellers have, in the past, dwelt in glowing terms upon the precious stones or metals of the country in a manner which appears, to those who are familiar with the island, to be somewhat hysterical. Much of the literature on this subject is based on fabulous history or hearsay evidence such as comes to us in the present day in the form of "Travellers' Tales."

Gaudry has recapitulated in a most exhaustive manner probably all the information recorded by ancient writers, but modern research has failed to substantiate many of their assertions. It is beyond the scope of the present work to go into anything but the evidence presented in regard to the geological character of the island; for further information on the subject the reader is referred to the authorities already alluded to.

Taking the formations in the order given in the foregoing pages, the products of economic value which each of them contains are of the following nature:—

The Trypanian Series is specially remarkable for the extensive variety of marbles which are to be found in it. The existence of these marbles is the more remarkable because it has been the general belief of modern times that no such material was found in the island, and that the marbles found so abundantly among its ruined cities, temples, or churches had been imported from other countries. Gaudry perpetuated this error, if indeed he were not largely responsible for it, and he actually states that "*Chypre est dépourvue de marbre.*"

It is now placed beyond all doubt that the beds of marble are of great extent, and the varieties numerous and frequently beautiful. A number of the best specimens were, some three or four years ago, sent to Naples to be polished, and were at the same time submitted to a sculptor and expert in marble, who pronounced them to be of excellent quality, one being "equal to the best Parian Marble." These are now in possession of the Cyprus Government, and others will be found

in the British Museum among the specimens of Cyprus rocks collected during these researches.

The varieties of marble include white saccharoid, of both coarse and fine texture, the latter closely resembling Carrara stone; cream-colour, white, or bluish, and occasionally black, also pink or flesh colour. All these kinds will be found among the ruins of ancient edifices, as well as among the Byzantine, or perhaps more correctly the Neo-Byzantine, churches dating from the ninth to twelfth centuries. Indeed, with but one exception, there is not a single fragment of marble among these ruins which cannot be matched in the beds existing in the Kyrenia Mountains. This one exception was discovered on the site of the temple of Aphrodite at Kouklia, near Paphos, and consisted in a block of Nummulite limestone, weighing, perhaps, half a ton. No such rock has yet been met with in Cyprus, and it greatly resembles the Nummulite limestone of Ghizeh, in Egypt.

Another kind found in the neighbourhood of Olymbos, towards the eastern end of the Kyrenia range, is said to be similar to Attic marble.

In the neighbourhood of the castle of St. Hilarion, called by M. Gaudry the "God of Love," a peculiar kind of brecciated marble is found, consisting of fragments of white and grey marble, the interstices between them being filled with a reddish-brown cement, thus forming a species of natural mosaic, a very handsome stone for decorative purposes. It has not been found *in situ* in any other part of the island, yet in searching the ruins close to Paphos Port a fragment identical in every respect was discovered built into a garden wall, but evidently originally employed in some ancient building now no longer existing. Port Paphos stands at the south-west corner of the island and within the area of the Pliocene rocks, and it is improbable that this particular stone could have come from anywhere but the Kyrenian Mountains, on the north coast of Cyprus.

Coincidence is not proof, but since marble identical with that found in the ruins of ancient cities occurs in large quantities within the limits of the island, it is not likely that the ancients would have imported it from elsewhere.

The Trypanian rocks yield also a good quality of clay, occurring in pockets, and employed by the villagers in covering the roofs of their houses, which, in accordance with the fashion of Levantine countries, are all flat and made of sticks and brushwood, covered with mud or clay. ✓

The most useful product of these limestones, however, is lime, the quality of which is excellent, as may be judged from the subjoined analysis of lime made from a marble collected from the neighbourhood of Dikomo.

LIMESTONE (BEFORE BURNING).

Moisture	.	.	.	.	0.15
Insoluble Silica	.	.	.	.	0.38
Soluble Silica	.	.	.	.	0.03
Alumina and Iron Oxides	.	.	.	.	2.50
Calcium Carbonate	.	.	.	.	92.28
Magnesium Carbonate	.	.	.	.	4.64
					99.98

Note.—The analyst described this as pure marble.

LIME (AFTER BURNING) UNSLAKED.

Moisture	.	.	.	.	6.90
Insoluble Silica	.	.	.	.	.58
Soluble Silica	.	.	.	.	.31
Iron and Aluminium Oxide	.	.	.	.	7.70
Calcium Oxide	.	.	.	.	80.09
Magnesium Oxide	.	.	.	.	4.47
					100.05

The best lime is obtained from the neighbourhood of Dikomo, Kythraea, and Kyrenia or Kazaphani, the stone being all procured from the Trypanian rocks.

Lime, however, has also been obtained from some of the Idalian limestones, though not in such large quantities. Among these may be cited Ambelikou, near Karavostassi, and Koronia, between Lefka and Nikitari, which are outliers on the Igneous rocks. Samples collected from these places yielded the following analyses:—

AMBELIKOU.

LIMESTONE (BEFORE BURNING).

Moisture	.	.	4.74
Calc. Carb.	.	.	94.28
Magnes. Carb.	.	.	0.98
			100.00

LIME.

Moisture	.	.	5.63
Calc. Oxide	.	.	90.60
Calc. Carb.	.	.	3.27
Magnes. Oxide.	.	.	0.50
			100.00

KORONIA.

LIMESTONE (BEFORE BURNING).

Moisture	.	.	8.24
Insol. Silica	.	.	1.48
Sol. Silica	.	.	0.95
Calc. Carb.	.	.	69.03
Iron and Al. Oxide	.	.	4.81
Magnes. Carb.	.	.	15.49
			100.00

LIME.

Moisture	.	.	6.68
Insol. Silica	.	.	1.05
Sol. Silica	.	.	2.88
Calc. Oxide	.	.	44.27
Calc. Carb.	.	.	12.60
Iron and Al. Oxide	.	.	15.72
Magnes. Oxide	.	.	16.80
			100.00

The process of burning the lime is of the simplest description. The kiln is of the "open" type, circular in plan, and about 30 or 40 feet in diameter. The stone to be burnt is piled up in layers alternating with green timber or brushwood until the stack reaches a height of some 8 or 10 feet; the firewood is kindled at the centre of the top of the pile, and the kiln is allowed to remain until the whole of the wood has been consumed. It may be mentioned incidentally that the same type of kiln is adopted in the burning of gypsum for the production of plaster of Paris, but the stacks are of considerably smaller dimensions.

The Kythraean Series of rocks yield few, if any, products of any consequence beyond building-stone, and this is not of particularly good quality. Slabs, however, of some size may be got in certain localities where the sandstones are tabular and less flexured.

Among the clays of this series is found a number of dark, bluish-grey bands, which contain a small percentage of carbon, accounting for the colour, no doubt. A specimen taken from the neighbourhood of Khelones, in the Carpas, has given the following analysis:—

BLUISH-GREY CLAY.

Moisture	1·07
Carbon	4·15
Silica	55·69
Iron Oxide	8·58
Aluminium Oxide	15·41
Calcium Carbonate	15·10
	100·00

So small a percentage of carbon renders it of no value for commercial purposes, though it may be possible to find a higher proportion of this mineral as the depth below the surface increases. Similar clay is said to be found in the neighbourhood of Psevda.

The rocks of the Idalian Series are probably more productive than those of any other formation in the island.

Gypsum is perhaps the most important product, and from it plaster of Paris is obtained by burning the fine-grained sulphate of lime, or the crystalline selenite. It constitutes an important industry, and a large export trade is carried on in it. The process is conducted generally on the most primitive lines; the raw material, after being burnt, is subsequently pulverised by beating it with a heavy stick and sifting. Mills for grinding the burnt gypsum have been established, however, at Larnaca and Limassol, which are the principal centres of the trade.

Patriki, near Famagusta, is also an important centre of the same industry, and there are numerous other places where gypsum is produced. The largest quarries are at Aradippou, near Larnaca, at Yermasogia, near Limassol, and at Gastria and Patriki.

The same fine-grained beds, which are frequently remarkable for their even bedding, yield also slabs for pavements and window sills, and in this form are known as "Marmaras," or Marbles, and it should be explained that the Cypriot equivalent for marble such as is found in the Trypanian rocks is "Khioni" (pronounced Shioni), meaning also snow. The texture of this gypsum "marmara," is such that it can be sawn to any pattern, and planed or dressed with an adze. It has been much used for the purposes above-mentioned and for interior decoration, but has the disadvantage of exuding moisture at the approach of rain or during rainy weather.

In appearance it is yellow or grey, and the darker-hued varieties are reckoned the more durable. It will not stand exposure to the weather, and is rapidly erode by contact with running water.

Grains and nodules of native sulphur are commonly found in the "marmara" stone, but not in sufficient quantity or purity to render its collection profitable.

Alabaster of good quality is obtained from the selenite beds, but is not employed as fully as it deserves to be. The best, if not the only, instance of its employment in recent years for internal decoration is to be found in the hall and staircase of the Royal Hotel at Larnaca, where its introduction reflects great credit on the judgment and enterprise of the builder. This stone came from the neighbourhood of Pyla, where the deposits, though not as extensive as in some parts of the island, contain probably the best quality.

In the neighbourhood of Athienou the Miocene Marls become massive and fine grained in texture, somewhat friable and staining the hands, and have the appearance of a white siliceous chalk. This stone is very amenable to the tool, and may be cut or dressed to any shape. From it are derived troughs for dyeing or washing, slabs for various purposes, and as it possesses the virtue of being in some measure fire-proof, is used instead of fire-bricks for stoves and hearths.

The flint and chert intercalated in the Tabular Marl yields the necessary material for making an agricultural implement known as the "dhokani." This is made from a board about 4 feet long and 2 feet wide, which is studded on the underside with sharp-edged flints. It is employed for thrashing corn, and is drawn about on the harvested straw until nothing remains but chaff or "chopped straw." The implement may possibly be a remnant of the Neolithic age.

Where the marls come in contact with the Igneous rocks (see

p. 34), terra-umbra is found in considerable quantities, and is collected chiefly at Mavrovouni and in the neighbourhood of Limassol, and an export trade is carried on in it. It undergoes no process of refinement in Cyprus, but is treated principally in Italy, whither the majority of it goes.

Pliocene Beds.—The shelly limestones of the Pliocene and Pleistocene deposits furnish a better quality of building-stone than any other formation in Cyprus, and it has been quarried at many places. Most of those have been mentioned in Chapter VI., where the several varieties of the stone were described. A harder quality of stone is obtained in some localities from which millstones are obtained.

In Nicosia many ancient churches, and the mediæval cathedral of Agia Sophia in particular, bear testimony to the durable property of these shelly limestones, and in the latter building the mouldings and sculpture are as clean cut and clearly defined as on the day they were erected, though part of the building dates from the thirteenth century. So with the mediæval churches of Famagusta, the cathedral of which in its turn dates from the fourteenth century; and although the once beautiful city is now little better than a heap of ruins, the details of the carvings have suffered little by age. Much may be due to the non-corrosive atmosphere, yet not all, for none but good stone could have withstood the centuries of exposure, even in the mildest and most equable of climates; and the same may be said of the Kyrenia stone.

As regards the Igneous rocks, their industrial uses are few at the present time, though there are not wanting evidences that early in the island's history they were exploited for the metals they contained and may still contain.

Copper is said to have been abundant at one time—so much so that the name of the metal is said to have been derived from that of the island, namely, ὁ κύπρος. But whether the metal was named after the island, or the island after the metal, is a moot point and remains yet to be determined.

The search for precious metals, whether iron or copper, extended throughout the greater part of the southern mountain range, the centres of activity being indicated by enormous masses of scoria or slag. The principal places where these accumulations occur are Korno, Lythrodonda, Mitzero (which some authorities hold is the site of ancient Tamassus), Katydhata, Lefka, Limni (where mining operations have recommenced within the last few years), Lyso, Ora, Drapia, etc. It is probable that copper was the object, and it is not unworthy of remark that all these places are situated on what may be described as the fringe of the Igneous masses of the southern mountains,

as though suggesting that the lodes occur between the Igneous and the sedimentary rocks, or more probably in the altered rocks of the former series.

In every instance, except at Limni, the mining operations have been confined to the surface, which goes to show, probably, that they were initiated chiefly by the Phœnicians, and perhaps even conducted exclusively by them. Limni was probably exploited by the Greeks or Romans subsequently, who may have been responsible for the introduction of the system of mining by shafts and galleries, of which indications still remain; and it is acknowledged that either or both of these nations re-smelted much of the slag, and extracted much of the residuary minerals remaining from the more primitive operations of their predecessors.

Accumulations of slag are also met with in many parts of the central mass of the Troödos Mountains, even on the summit of Troödos itself. In these cases it is probable that iron was the metal in view, and may have been obtained from the Pyrites which abound in the rocks of this neighbourhood. One of the best instances of these operations occurs at Kryso-Vrysis, on the road to Troödos. The word in the vernacular stands for "Golden Spring," and no doubt originated in the abundance of Pyrites found in the neighbourhood, and still mistaken by the Cypriot for gold.

The Serpentes also yield Asbestos (Fibrous Hornblende) in large quantities. It is known locally as Amiandos, but it is of little commercial value, as the fibre is short. The term employed by the Cypriotes for the common lime of commerce is "asbestos," a peculiarity which philologists may be able to explain.

In several parts of the southern mountains, also, there are extensive deposits of Puzzolana, known also as Trass or Terrass. It is well known and largely used still on the Continent of Europe, but is unfamiliar to English builders. It possesses the virtue of rendering common lime hydraulic, and the following is an analysis of a specimen taken from the neighbourhood of Krysovrysis:—

PUZZOLANA.

Moisture	2·55
Insoluble Silica	55·50
Soluble „	11·00
Iron and Alum. Oxides	21·34
Calcium Carbonate	5·45
Magnesium Carbonate	4·10
	99·94

Until the opening of the road, in 1900, this material was not known to exist in Cyprus. It has been since largely used for building purposes.

Among the weathered basalts of the lower mountains, and in the neighbourhood of Malounda, a product known as Terre Verte, of considerable value as a pigment, is found, and an export trade was carried on in it some years ago. Its value in a state of purity consists in the fact that it is free from copper or arsenic, the hue resulting from the presence of a silicate of iron, as indicated by the following analysis:—

TERRE VERTE.				
Moisture	.	.	.	4.50
Silica	.	.	.	52.50
Ferrous Oxide	.	.	.	26.44
Potash	.	.	.	15.72
Magnesia	.	.	.	0.84
				100.00

Pure Terre Verte should consist almost exclusively of silicates of iron and potash, so that it will be seen there are few impurities in that occurring in Cyprus.

In the neighbourhood of Lefka, and also in that of Lefkara, are deposits containing alum. It has long been known to the natives of the neighbourhood, who have employed it for washing clothes, but its existence has only recently become public. It is found in the decomposed rocks associated with altered igneous rocks, and is contained in a whitish sandy earth. It appears on the surface as a white efflorescence after a shower of rain, and is then collected and used in this form for domestic purposes. In this condition it contains a number of impurities, among the principal of which is sulphur.

A good pottery earth is obtained also among the weathered igneous rocks, from which wine jars, chatties, and a number of other utensils are made, besides roofing and flooring tiles. The principal centres of this industry are Korno, Phini, and Galata.

A specimen taken from the last-named locality yielded the following analysis:—

RED CLAY FROM GALATA.				
Moisture	.	.	.	5.00
Insoluble Silica (Sand)	.	.	.	65.40
Soluble Silica	.	.	.	6.00
Iron Oxide	.	.	.	9.49
Alumina	.	.	.	7.10
Calcium Carbonate	.	.	.	2.30
Magnesium Carbonate	.	.	.	4.48
				99.77
				Loss
				100.00

Stone for macadamising roads is obtained from some of the diabases, but none of the Igneous rocks yield a stone that can be used for building, owing to their hardness and want of grain. Millstones are also occasionally obtained from among the Igneous rocks. The doorstep of the churchyard at Trimiklini, to the south-east of Troödos, is partly composed of a slab of stone which has been dressed and grooved as though once used as a grindstone. Its structure corresponds with that of Andernach lava, so much employed for this purpose by the Romans; but no stone of this character has been met with *in situ* during these researches, and this fragment may perhaps be only an importation—a possible remnant of the Roman occupation of Cyprus.

A number of gems are said to have been found in Cyprus at one time, but the only ornamental stone of this nature now known is the Rock Crystal, or Paphos diamond, found principally in the district of Paphos. It bears no comparison with the true diamond, however, either in appearance or chemical composition, being purely Quartz.

The Igneous rocks of the northern range appear to be devoid of metals of any kind, and they are not known to yield anything of any commercial value.

Springs.—Mineral springs are met with in various parts of the island. All are credited with remarkable virtues, but it is feared that in many cases such qualities are the product of the imagination in a superstitious mind. The principal springs are (1) in the neighbourhood of the monastery of Ag. Chrysostomos, near Buffavento, which issues from the Trypanian limestones; (2) at Kalopanayiotis, near Troödos, issuing from diabase rocks; (3) at Yiolou and Sarama, in the Paphos district, issuing from the Idalian Series. They are charged with sulphur, and those at Yiolou are more especially so. Those at Sarama are also thermal in some measure. Both of these are good for affections of skin—eczema, etc.—and the Kalopanayiotis water has been known to give relief in cases of malarial fever and rheumatism.

In the Pasha Livadhia Valley, above Devil's Dyke, and also in a neighbouring valley through which the Ag. Nicola stream descends from the northern slopes of Troödos to Kakopetria, there are said to be springs of Epsom salts, but the statement has never been verified.

Salt Lakes.—The salt deposited in the salt lakes of Larnaca and Limassol is simply produced by the evaporation during the hot season of the salt water penetrating thereto from the sea during the winter. Although much of the soil in certain parts of Cyprus contains an excessive quantity of salts, they are principally magnesian, and it is certain that the quantity in the soil is not sufficiently large to account for the enormous accumulations of common salt, *i.e.* chloride of sodium,

in the two localities named. It was supposed at one time that these salt lakes had their origin in subterraneous accumulations of rock salt, but this illusion was dispelled in the course of a memoir on the Salt Lake of Larnaca (vide *Quarterly Journal Geological Society*, vol. lvi., of 1900), to which reference has already been made.

Soils.—The soil of Cyprus is possessed of remarkable and undoubted fertility. In the mountains the vine is cultivated alike within the area of the Igneous rocks as well as that of the Tabular Marls. The best wine is produced from vines growing in soil of the latter description. The wine centres are principally Omodhos, Vasa, Mallia, Arsos, Agios Ambrosios, etc. The important wine factory of Perapedhi is supplied from grapes grown in the neighbourhood of Kilani, etc., also on the white soil.

Around the Adelphi range, or what is generally known as the Pitzilia villages, the people are employed almost exclusively in the production of wine, but in this case the vines grow on soils of the igneous rocks.

To enumerate all the various kinds of fruit and other trees is outside the scope of the present work, but the following may be cited as growing among the hills of Cyprus besides the vine, namely, the walnut, filbert, olive, cherry, apple, pear, medlar, etc. It is probable that most of these thrive in such localities more by reason of climatic conditions than those of soil.

It is in the low country, the Messaoria Plain, where the fertility of the soil is most apparent. In the best parts of this area the soil is light, loamy, and almost entirely free from rock and stone. Indeed it is not unusual to find a water-course the scarps of which show a depth of 10 or even 15 feet of loam, the whole of which, it may be safely assumed, has been borne down from the adjoining mountains by successive rain-storms and floods.

Such soil is eminently suited to the cultivation of cereals, and given a sufficiency of seasonable rain its productiveness could not be surpassed by any country in the world.

APPENDIX I.

AMONG the specimens brought from Cyprus and now deposited in the Mineralogical Department of the British Museum, the following is a brief summary:—

From the Kyrenia Mountains.—A hard white marble, Trypanian, collected near the monastery of Ag. Chrysostomos.

A dull white marble, Trypanian, from the crest of the ridge near Kantara.

A dull pinkish-red marble from near Kantara, identical with that from which a column among the ruins of Salamis is composed.

A whitish compact marble from near St. Hilarion, and a second specimen from the same neighbourhood, but whiter.

A compact grey and white marble from near Olymbos. This has been compared with Attic Marble.

A white saccharoid marble from near Ag. Chrysostomos.

A pink limestone enclosing small angular fragments of a black siliceous stone from near Bellapais. This is capable of taking a polish, and of being made a good decorative stone.

A considerable variety of breccia and brecciated marble is found among the rocks composing the Kyrenia Mountains, among the best specimens being those from near St. Hilarion, which consist chiefly of fragments of white and grey marble with the interstices filled with a reddish-brown calcareous matter, composing a species of natural mosaic; it takes a good polish, and is a handsome stone. A precisely similar specimen is to be found among the ruins of Port Paphos. Other kinds are met with, the predominating hues of which are either white, cream-colour, or bluish, as at Muti Tircas, Skasmata, and elsewhere.

Near Sisklipos and in the neighbourhood of St. Hilarion are the principal places where a dark blue-grey friable rock is found. This is said by Gaudry to be bituminous.

Near Aghirda is to be found a specimen apparently of quartz-felsite, which has been altered by pressure, and is cleaved and vitreous. Gaudry describes this as “*étiré*,” *i.e.* stretched or elongated in respect to fibre or grain. At Buffavento the rock reveals a similar structure.

Dolomite is found near Pentadactylos, and near Sisklipos a brecciated dolomitic limestone.

Near Ag. Chrysostomos are masses of white limestone having a surface coating of rust-coloured earthy matter.

From the Kythraean Beds.—Of two characteristic specimens of these beds taken from the neighbourhood of Mia Millia, one is a grey felspathic sandstone compacted by carbonate of lime and the other as a compact silty marlstone.

A grey felspathic quartzite, probably a sandstone altered by contact with igneous rock, is found near Ag. Dimitrianos in the Paphos district. In the

same locality the lustrous-looking dark sandstones of the same series contain a black hematitic iron ore.

At Potamiou, near Polis, is a large isolated mass, a conspicuous feature of the landscape, consisting of yellowish-red porcellanite.

From the Idalian Beds.—A siliceous chalk from Goshi containing Globigerina and Radiolaria.

Flints of several kinds such as an agaty flint near Kophino, a pale greyish-white flint with a flaky resinous fracture from Paralimni, and a fawn-coloured flint at Goshi.

A compact white crystalline limestone near Paralimni.

A granular crystalline white marble and a white saccharoid marble from the neighbourhood of Pyrgos in the Carpas. This has been compared with Parian.

White crystalline marble is also met with at Cape Greco and at Stavrokonos, Paphos.

A specimen of the so-called Terra Umbra taken from the neighbourhood of Ag. Varvara, Nissou, seemed to be shale or baked marl or clay, and resembles a bituminous shale.

From the Pliocene Beds.—The building-stone produced from the quarries in these beds is a semi-compacted calcareous sandstone, consisting almost entirely of organic débris.

APPENDIX II.

MORE DETAILED DESCRIPTIONS OF SOME OF THE ROCKS.

Trypanian Series.—A slide for microscopical examination was made from one of these rocks.

A light grey flint from basal conglomerate, St. Catherine's Pass, Kyrenia Mountains. This is of an unusual character, consisting of a clear siliceous matrix (not definitely chalcedonic) enclosing grains of various shapes; many are oval and resemble the interior portions of oolitic grains, while round them is a ring of clear silica, which occupies the place of the calcitic coating of such a grain; other fragments are apparently rolled pieces of shell, but no definite organism can be seen. This rock is regarded as a silicified oolite comparable to the silicified oolites in the Portland series of the Vale of Wardour, Wiltshire.

Kythraean Series.—There are several specimens from this series, and slides have been prepared from two of them. All have the same character of calcareo-siliceous rocks varying in colour from buff or grey to dark grey or brownish-black. All the specimens are hard compact rocks, and consist of siliceous minerals embedded in a calcareous matrix, but the gritty ingredient is not quartz. Most of them are highly felspathic, and some may be called felspathic sandstones; others are more micaceous; others, again, are so fine-grained and so calcareous that they would be better described as marlstones,

the constituents being a very fine kind of felspathic silt embedded in a marly matrix. Both slides contain two or three small tests of *Globigerina* and a few fragments which may be bits of Molluscan shells. These rocks are the "macignos" of Gaudry.

Dr. Teall has been kind enough to examine the two slides, and to determine the minerals that are seen in them. These he reports as felspar, augite, and biotite, with some grains which may be pseudomorphs after olivine. No quartz grains were noticed in either slide, and the rock evidently consists entirely of the detritus of volcanic minerals enclosed in a limestone matrix (not infiltrated calcite, but limestone sediment). The mineral fragments may have been derived from the detrition of an area of volcanic rocks, or they may be volcanic dust blown out of contemporaneous volcanic vents. In other words, they indicate the close neighbourhood either of active volcanos or of a large area of previously erupted volcanic rocks.

Idalian Series (Miocene).—This series of limestones and marls has been described on p. 22 *et seq.*, and it was noted that flints were common in some of the beds. We have had slides made from several of the limestones and flints, and they all prove to be very interesting rocks. The limestones vary in character, but the shelly limestone attributed to this series is probably the highest member of it; the greater part seems to consist of chalky limestones and marls which originated in deeper water than any of the other Cyprian rocks.

1. A white siliceous chalk from Paralimni in the south-east corner of the island. A slice of this examined by Mr. W. Hill proves to be a calcareo-siliceous chalk comparable and very similar to some of those which occur in the Oceanic Series of Barbados. It consists of a fine matrix enclosing many large *Globigerina*, with a few minute *Textularia*, and a large number of Radiolaria. These organisms form from 30 to 35 per cent. of the rock mass; there are no sponge-spicules nor any shell-fragments, and the only mineral particles are a few minute grains which are probably quartz. The matrix is certainly in part siliceous, for the rock will not break down easily even in a 20 per cent. acid solution, and this silica is doubtless mainly derived from the Radiolaria.

2. The flints from Paralimni were also cut, and two of them prove to be simply silicified portions of the same kind of chalk. They are full of *Globigerina*, but the skeletons of the Radiolaria have disappeared, and it is only here and there that an outline of one can be recognised. In this respect they resemble the siliceous concretions which occur in the Oceanic Series at Castle Grant, Barbados. Another point of similarity is the peculiar condition of the silica, which is not globular like that of many chert-nodules, nor is it chalcedonic except where it has segregated freely in the hollow chambers of the *Globigerina*; it more resembles the glassy silica of the Barbadian concretions. The fracture of these flints is in accordance with their microscopical structure, being of an opaline or resinous aspect, but some of them include patches and bands of clear chalcedony. In colour they vary from pale buff or cream to a pale yellowish-brown or fawn-colour.

3. Soft whitish marl from Paralimni. This seems to be also a siliceo-calcareous rock of oceanic character, but it has undergone more destructive

change than the chalk. The matrix is a fine ooze, and is probably a mixture of minute calcareous and siliceous particles. Through this tests of *Globigerina*, both large and small, are dispersed; but no definite remains of Radiolaria or of other organisms are discernible; hence the material looks like a Globigerina-ooze. If siliceous organisms were originally present, they have been dissolved out by percolating water.

4. A yellowish-white shelly limestone from Paralimni. This rock is entirely composed of organic fragments, the most abundant being Foraminifera, pieces of the calcareous alga *Lithothamnion*, and fragments of Echinodermal tests. There are also some shell-fragments and débris of Bryozoa. It is, in fact, a rock which resembles the well-known Leithakalk of Vienna, and it is also very much like some of the limestones which occur in the Miocene of Malta.

Dr. Hinde was kind enough to cut some other slices of this rock, and informs me that he can identify the following Foraminifera: *Amphistegina* (fairly common), *Polytrema planum*, *Orbitoides*, *Gypsina*, *Operculina*, *Miliolina*, and *Globigerina*, but the last is somewhat rare.

5. A white crystalline limestone from near ancient Pyrgos in the Carpas. The slice shows that it is completely calcified, the rhombohedral crystallisation of calcite being clearly visible throughout, and no trace of an organism is discernible.

Pliocene Series.—This series appears to consist mainly of fine calcareous sands and shelly limestones. One of the latter—a pale yellow limestone—has been cut for examination, and the slide shows that it has a fine calcareous matrix containing a quantity of organic remains and fragments, principally angular fragments of shell, Molluscan and Echinodermal; broken and perfect Foraminifera, among which *Globigerina* are common; with a few pieces of *Lithothamnion*, Bryozoa, and what seem to be sections of *Serpula* tubes. Dr. Hinde has also examined this rock, and can identify *Miliolina* and *Gypsina* as well as *Globigerina*.

The slide shows many empty spaces of various shapes, and a glance at the rock specimen shows that most of these are spaces from which shell-fragments or small perfect bivalve shells have been dissolved, many casts of these shells being visible with a few of small Gasteropods.

A small fragment of the rock, treated with acid and then washed, left a small residue of quartz grains.

APPENDIX III.

LIST OF FORAMINIFERA FROM THE PLIOCENE MARL
OF MYRTOU.

By F. W. MILLETT, Esq.

- Biloculina depressa*, *d'Orb.*
Spiroloculina nitida, *d'Orb.*
Miliolina Ferussaci, *d'Orb* (?).
Sigmoilina tenuis, *Czjzek.*
Planispirina celata, *Costa.*
Psammosphæra fusca, *Schulze.*
Reophax papillosa, *Neug.*
Textularia sagittula, *Deffr.*
 " " var. *jugosa*, *Brady.*
 " " var. *lythostrota*, *Schwag.*
 " *agglutinans*, *d'Orb.*
 " *concava*, *Karrer.*
Verneuilina spinulosa, *Reuss.*
Tritaxia caperata, *Brady.*
Bigennerina nodosaria, *d'Orb.*
Gaudryina pupoides, *d'Orb.*
 " *siphonella*, *Reuss.*
Clavulina communis, *d'Orb.*
Bulimina elegans, *d'Orb.*
 " *elegantissima*, *d'Orb.*
 " " var. *acicula*, *Andreae.*
 " *pyrula*, *d'Orb.*
 " *ovata*, *d'Orb.*
 " *affinis*, *d'Orb.*
 " *aculeata*, *d'Orb.*
 " *inflata*, *Sequenza.*
Virgulina Schreibersiana, *Czjzek.*
Biforina porrecta, *Brady.*
Bolivina punctata, *d'Orb.*
 " *dilatata*, *Reuss.*
 " *robusta*, *Brady.*
 " *Beyrichi*, *Reuss.* var. *alata*, *Sequenza.*
 " *æuariensis*, *Costa.*
 " *reticulata*, *Hantk.*
 " *plicata*, *d'Orb.*
Pleurostomella alternans, *Schwag.*
Cassidulina lævigata, *d'Orb.*
 " *crassa*, *d'Orb.*
 " *subglobosa*, *Brady.*
 " *Bradyi*, *Norman.*
Chilostomella ovoidea, *Reuss.*
Lagena globosa, *Montagu.*
 " *apiculata*, *Reuss.*
 " *lævis*, *Montagu.*
 " *aspera*, *Reuss.*
Lagena hispida, *Reuss.*
 " *striata*, *d'Orb.*
 " *sulcata*, *W. and J.*
 " *acuticosta*, *Reuss.*
 " *semistriata*, *Will.*
 " *hexagona*, *Will.*
 " *reticulata*, *Macgillivray.*
 " *lævigata*, *Reuss.*
 " *acuta*, *Reuss.*
 " *marginata*, *W. and B.*
 " *Orbignyana*, *Sequenza.*
 " *castrensis*, *Schwag.*
Nodosaria lævigata, *d'Orb.*
 " *radicula*, *Linné.*
 " " var. *annulata*, *T. and B.*
 " *brevis*, *d'Orb.*
 " *simplex*, *Silvestri.*
 " *calomorpha*, *Reuss.*
 " *pyrula*, *d'Orb.*
 " *farcimen*, *Soldani.*
 " *filiformis*, *d'Orb.*
 " *pauperata*, *d'Orb.*
 " *consobrina*, *d'Orb.*
 " *soluta*, *d'Orb.*
 " *longiscata*, *d'Orb.*
 " *arundinea*, *Schwag.*
 " *communis*, *d'Orb.*
 " *Roemeri*, *Neug.*
 " *mucronata*, *Neug.*
 " *subtertenuata*, *Schwag.*
 " *hispida*, *d'Orb.*
 " *Adolphina*, *d'Orb.*
 " *lepidula*, *Schwag.*
 " *semirugosa*, *d'Orb.*
 " *scalaris*, *Batsch.*
 " *proxima*, *Silvestri.*
 " *perversa*, *Schwag.*
 " *raphanus*, *Linné.*
 " *obliqua*, *Linné.*
 " *vertebralis*, *Batsch.*
Lingulina carinata, *d'Orb.*
 " *gemina*, *Silvestri.*
Lingulinopsis sequana, *Berth.*
Frondienlaria inæqualis, *Costa.*
 " *interrupta*, *Karr.*

- Fronicularia raricosta*, *Karr.*
Rhabdogonium tricarinatum, *d'Orb.*
Marginulina glabra, *d'Orb.*
 " *hirsuta*, *d'Orb.*
 " *costata*, *Batsch.*
 " " var. *spinulosa*, *Costa.*
Vaginulina legumen, *Linné.*
 " *recta*, *Reuss.*
 " *cymba*, *d'Orb.*
 " *linearis*, *Montagu.*
 " *striata*, *d'Orb.*
Cristellaria Wetherellii, *Jones.*
 " *Schlönbachi*, *Reuss.*
 " *variabilis*, *Reuss.*
 " *crepidula*, *F. and M.*
 " *acutauricularis*, *F. and M.*
 " *latifrons*, *Brady.*
 " *italica*, *Defr.*
 " *gibba*, *d'Orb.*
 " *rotulata*, *Lam.*
 " *vortex*, *F. and M.*
 " *orbicularis*, *d'Orb.*
 " *cultrata*, *Montfort.*
 " *calcar*, *Linné.*
 " *echinata*, *d'Orb.*
 " *ariminensis*, *d'Orb.*
Amphicoryne falx, *P. and J.*
 " *Bradyi*, *A., Silvestri.*
Polymorphina lactea, *W. and J.*
 " *amygdaloides*, *Reuss.*
 " *gibba*, *d'Orb.*
 " *myristiformis*, *Will.*
 " *hirsuta*, *B. P. and J.*
Dimorphina compacta, *B. P. and J. var.*
Uvigerina canariensis, *d'Orb.*
 " *tenuistriata*, *Reuss.*
 " *pygmæa*, *d'Orb.*
 " *Schwageri*, *Brady.*
 " *angulosa*, *Will.*
 " " var. *spiniper*, *Brady.*
 " *aculeata*, *d'Orb.*
 " *asperula*, *Czjzek.*
Sagrina striata, *Schwag.*
Ramulina globulifera, *Brady.*
 " *aculeata*, *Wright.*
Globigerina bulloides, *d'Orb.*
 " *rubra*, *d'Orb.* var. *adriatica*, *Forn.*
 " *conglobata*, *Brady.*
Globigerina æquilateralis, *Brady.*
Orbulina universa, *d'Orb.*
Hastigerina pelagica, *d'Orb.*
Pullenia sphaeroides, *d'Orb.*
 " *quinqueloba*, *Reuss.*
Sphaeroidina bulloides, *d'Orb.*
 " *dehiscens*, *P. and J.*
Cymbalopora Poeyi, *d'Orb.*
Discorbina globularis, *d'Orb.*
 " *Binkhorsti*, *Reuss.*
 " *rosacea*, *d'Orb.*
 " *araucana*, *d'Orb.*
 " *orbicularis*, *Terg.*
 " *Bertheloti*, *d'Orb.*
 " " var. *Baconica*, *Hantk.*
 " *rugosa*, *d'Orb.*
 " *tuberculata*, *B. and W.*
Planorbulina mediterraneensis, *d'Orb.*
Truncatulina refulgens, *Montfort.*
 " *lobatula*, *W. and J.*
 " *tenuimargo*, *Brady.*
 " *Wuellerstorfi*, *Schwag.*
 " *Haidingeri*, *d'Orb.*
 " *Akneriana*, *d'Orb.*
 " *Ungeriana*, *d'Orb.*
 " *tenera*, *Brady.*
 " *pygmæa*, *Hantk.*
 " *præcincta*, *Karr.*
 " *reticulata*, *Czjzek.*
Anomalina ammonoides, *Reuss.*
 " *ariminensis*, *d'Orb.*
Pulvinulina auricula, *F. and M.*
 " *Hauerii*, *d'Orb.* (not typical).
 " *patagonica*, *d'Orb.*
 " *Micheliniana*, *d'Orb.*
 " *umbonata*, *Reuss.*
 " *elegans*, *d'Orb.*
Rotalia Beccarii, *Linné.*
 " *Soldani*, *d'Orb.*
Nonionina depressula, *W. and J.*
 " *umbilicatulata*, *Montagu.*
 " *stelligera*, *d'Orb.*
 " *Boueana*, *d'Orb.*
 " *scapha*, *F. and M.*
 " *turgida*, *Will.*
Polystomella striatopunctata, *F. and M.*
 " *crispa*, *Linné.*
 " *macella*, *F. and M.*

The Foraminifera of this deposit form an assemblage which is closely allied to that found at Kar Nicobar, and to that of several Italian Pliocene deposits. At the same time it has a distinct character of its own. With regard to *Discorbina tuberculata*, this is, I believe, the first record of its occurrence as a fossil. —F. W. M.



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